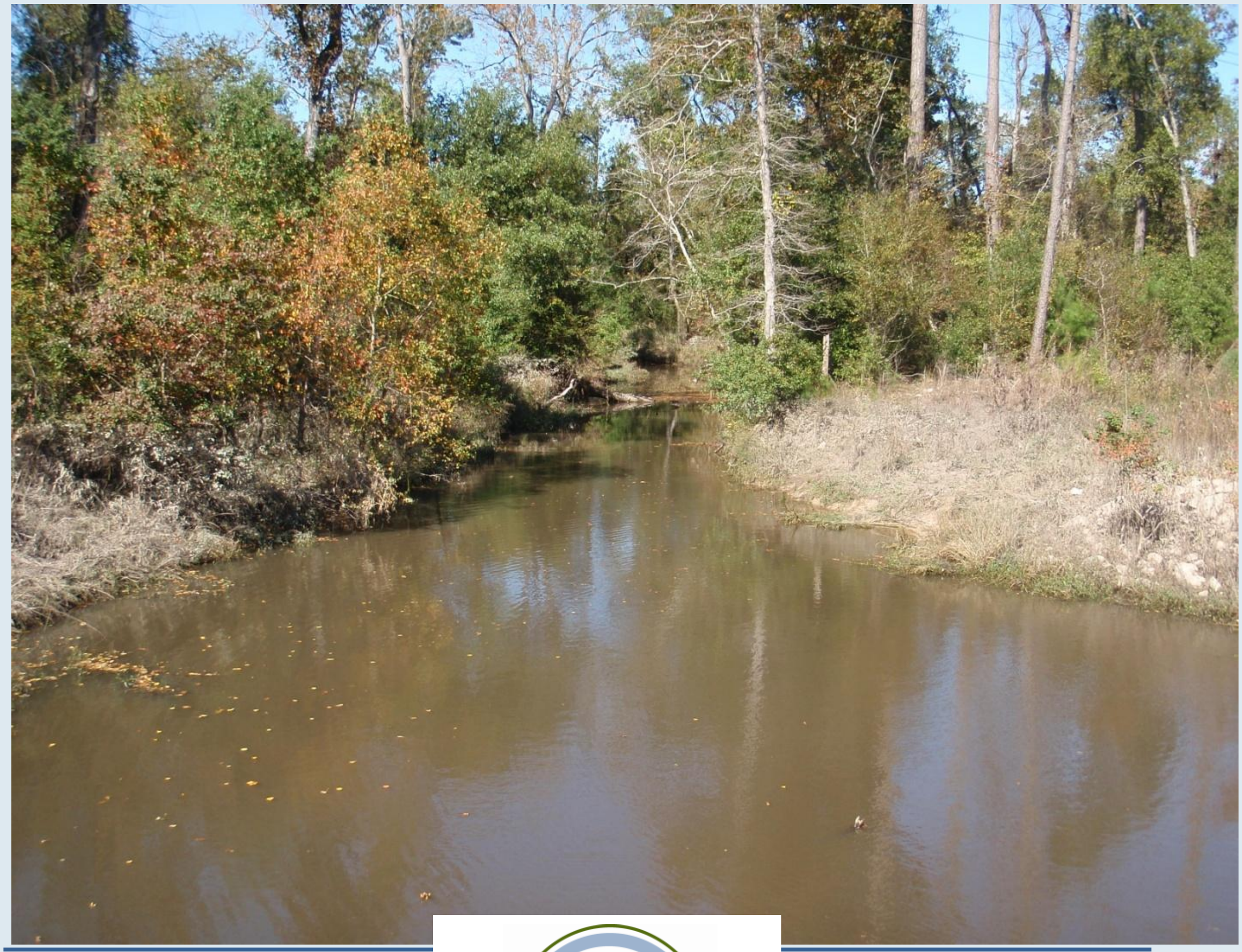
MARSH BAYOU WATERSHED

STATE WATERBODY SUBSEGMENT 030603

LOUISIANA DEPARTMENT OF ENVIRONMENTAL QUALITY

Watershed Implementation Plan

2010



DEQ LOUISIANA

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Executive Summary

This document represents a revision of the Marsh Bayou Watershed Implementation Plan for sub-segment 030603, of the Calcasieu River Basin. The plan was initially written in 2003 but has been revised to address U.S. Environmental Protection Agency's (USEPA) nine key elements of their 2004 national guidelines for Section 319 grants. Marsh Bayou has been included on the state's 303(d) list of impaired waters since 2002. Between 2002 and 2004, it was impaired because of low levels of dissolved oxygen. This prevented the bayou from meeting the fish and wildlife propagation use (FWP). In 2006, Marsh Bayou was also impaired because of high levels of fecal coliform bacteria in the water body. This prevented it from meeting the primary contact recreation designated use (PCR). The 2008 Integrated Report (IR) also lists Marsh Bayou for dissolved oxygen and fecal coliform bacteria, indicating that these water quality problems persist. This revision of the watershed plan includes new water quality data and information to assist the local landowners and stakeholders to understand what steps or actions they can take to improve their water quality in Marsh Bayou.

Dissolved oxygen levels in the bayou are often below the state's water quality standard. A Total Maximum Daily Load (TMDL) for oxygen demanding substances has been developed. The TMDL recommends a 67% load reduction of nonpoint source pollutants for the Marsh Bayou to meet water quality standards during the critical conditions. This is the hottest part of the summer and fall when the flows in the bayou are the lowest. The sediments and nutrients that contribute to this pollutant load enter the bayou throughout the year when it rains but exhibit the highest demand on the dissolved oxygen during these critical conditions of the year. During this time, the aquatic organisms that live within the bayou can become stressed because of the low levels of oxygen that is available for them to use in their metabolic processes. Since the Marsh Bayou Watershed has no "point source" wastewater dischargers that are permitted, the cause of the water quality impairment has been attributed to nonpoint source (NPS) pollution. Controlling existing sources and preventing new sources of NPS pollution within the watershed should improve dissolved oxygen, reduce fecal coliform and restore water quality in Marsh Bayou.

Marsh Bayou Watershed is best characterized as rural forestry and agricultural land. The land has higher elevations in the north that fade to a broad terrace region in the south. Historically, "mixed pine forest" consisting of long-leaf and slash pine covered most of the watershed except near the waterways where "bottomland hardwood forests" comprise the riparian areas. Forestry harvesting has occurred extensively throughout the watershed and many sites have been converted to agriculture, mostly soybeans and rice. The soils throughout the basin are moderately to highly erosive and are less fertile than others. Historical forestry operations resulted in much sediment and organic debris loading into local streams, which has altered the hydrology of the bayou causing conditions that are not conducive for good water quality. With below average flow rates, the bayou functions like a "sink" where the organic debris and nutrients become trapped after rainfall events. While there, these substances consume in-stream oxygen. Today most of the impacts from forestry result from the access roads and the increased rates and amounts of surface runoff. Higher peak flows resulting after rain events and extremely low flows during non-rain periods characterize the watershed. Access roads with "barren" ditches along side of them act as straight conduits that drain directly into local streams and are significant contributors of NPS loads. Whether from forestry, agriculture, or new construction, land use activities that are known to disturb the soil should implement best management practices (BMPs) to control/reduce sediment and nutrient runoff. In addition to controlling sources of sediment and nutrient runoff throughout the watershed, stream restoration measures should be considered for unstable and aggraded reaches of Marsh Bayou. Stream restoration measures for the unstable and/or aggraded reaches should be modeled after reference reaches of Marsh Bayou that are stable and conducive of good water quality.

Future growth and development within the Marsh Bayou Watershed should recognize that the Marsh Bayou Watershed is within a unique land area located at a point of convergence between two different eco-regions, the “hill region” and “terrace region”. As a result, there are land areas having many unique native plants from both eco-regions. Such areas in the watershed serve “critical” and “sensitive” functions and are of greater use to the watershed when preserved in their natural state. The watershed is also unique because of its close proximity to two major cities, Lake Charles and Houston, a major interstate system, a major shipping channel, and the gulf coast. New construction and development to address housing needs and economic growth are likely in the future. Maintaining the water quality in Marsh Bayou will require not only implementation of BMPs for controlling the current sources of NPS loading and stream restoration, but also watershed planning which can manage future NPS loading caused by future growth.

This watershed plan was originally written in 2003, but has been revised to comply with the 9 key elements that were included in USEPA’s 2004 Grant Guidelines for Section 319 of the Clean Water Act. USEPA Region 6 has required the states to make these revisions prior to the use of Section 319 incremental funds for project implementation.

USEPA’s Nine Key Elements

USEPA has included nine key elements in their national guidelines for the Nonpoint Source Program and Section 319 grants. The nine key elements include:

a. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan.

b. An estimate of the load reductions expected for the management measures described under paragraph © below.

c. A description of the NPS management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals, identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

d. An estimate of the amounts of technical and financial assistance needed associated costs, and/or the sources and authorities that will be relied upon, to implement this plan.

e. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

f. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious.

g. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

All of this information is intended to assist the local decision makers and landowners in understanding more clearly what their role needs to be in restoring the designated uses for Marsh Bayou.

1.0 INTRODUCTION

The Watershed Implementation Plan will address the nonpoint sources of pollutants that have caused water quality impairment in this watershed. Sub-segment 030603 was listed on the 2008 303(d) list for Louisiana as not fully supporting its designated uses of PCR and FWP. The causes for impairment cited in the 303(d) list included fecal coliform bacteria and low levels of dissolved oxygen (DO). In 1999, LDEQ conducted water quality sampling in Marsh Bayou. The results indicated that the concentration of dissolved oxygen was less than that of the water quality standard. As a result, Marsh Bayou was noted in the 305 (b) Report as being impaired for the fish and wildlife propagation use. The dissolved oxygen standard for Marsh Bayou that has been determined supportive of the designated use of fish and wildlife propagation is 5.0mg/L year round. A total maximum daily load (TMDL) was prepared for the Marsh Bayou Watershed by LDEQ after it was included on the 305 (b) Report. The *TMDL is the maximum amount of pollution the waterway can receive on a daily basis and continue to maintain its water quality standards.*

The Marsh Bayou Watershed TMDL was developed to estimate the total amount of “oxygen-demanding substances” the bayou can assimilate without violating the 5.0 mg/L dissolved oxygen water quality standard. A table of all the “designated uses” for Marsh Bayou and numerical water quality criterion is found in Appendix A. TMDL reports typically separate the point sources and nonpoint sources (NPS) within the sub-segment (watershed). No point-source dischargers were identified in the Marsh Bayou Watershed, only NPS loading (LDEQ Marsh Bayou TMDL 9/24/01). The TMDL report established a NPS load allocation, including a projected NPS pollutant load reduction.

The NPS Watershed Implementation Plan outlines how to reduce the NPS loading. The Plan also identifies the likely sources of NPS loadings and recommends the best management practices (BMPs) that are ideal for reducing the NPS pollutant load. BMPs are practices that have been determined as effective for controlling potential sources of NPS pollution. The NPS Implementation Plan outlines the basis for what types of BMPs are recommended in the Marsh Bayou Watershed to control NPS loading and a projected schedule for implementation (Volume 6 of the LDEQ Water Quality Management Plan).

1.1 ECO-REGION DESCRIPTION

Marsh Bayou Watershed lies in two of the three different eco-regions that make up the Calcasieu River Basin. The three different eco-regions that make up the Calcasieu River Basin are:

- The *South Central Plains* eco-region referred to as the “hill-region” comprises the northern portion of the Calcasieu Basin,
- The *Western Gulf Coastal Plain* eco-region known as the “terrace-region” comprises the central portion of the basin,
- The *Coastal Chenier Plain* coastal-region or “coastal marsh” in the southern portion of the basin.

The "hill region" is characterized by longleaf pine forests, has maximum elevations and relief, dendritic and trellis drainage, interior salt domes, wolds or cuestas (hard sedimentary rock), ironstone, excellent surface and groundwater resources, mature soils and the oldest rocks in the state. The soil types consist of coastal plain soils and flatwoods soils. Vegetation exists as longleaf pine forests (longleaf pines, slash pines, some hardwoods) and bottomland hardwoods (cottonwood, sycamore, willow, water oaks, gum, maple, and loblolly pine). (LDEQ 2001 via Kniffen, 1998).

The "terrace region" has intermediate elevations and relief, is an older alluvium, and has a large percentage of tabular surfaces. The terrace region extends from the "flatwoods" to prairies. Flatwoods are low relief areas with mixed longleaf pine forest, bagols, pimple mounds, dendritic drainage, and flatwoods soils. Vegetation exists as flatwoods forest (longleaf pine, oak, palmetto, and wiregrass). Throughout the terrace region are strips/pockets of cypress forests (cypress and tupelo), and bottomland hardwoods.

The "coastal region" is characterized by areas having low relief, prairie grassland, prairie soils, pimple mounds, dendretic streams, ice-age channels, and platin or mariais (small, shallow un-drained ponds in the prairies). Slow moving rivers that are tidally influenced near the gulf coast are common in this area.

Figure 1: Map of Louisiana Eco-Regions

1.2 CALCASIEU RIVER BASIN DESCRIPTION

The Calcasieu River Basin is located in southwest Louisiana and is positioned in a north-south direction between the Mermentau and Sabine Rivers. The drainage area of the Calcasieu Basin comprises approximately 3,910 square miles. Headwaters of the Calcasieu River are in the hills west of Alexandria. The Calcasieu River flows south for about 160 miles to the Gulf of Mexico. The mouth of the river is about 30 miles east of the Texas-Louisiana state line. The landscape in this basin varies from pine-forested hills in the upper end to brackish and salt marshes in the lower reaches around Calcasieu Lake and also includes the city of Lake Charles.

Figure 2: Calcasieu River Basin and Sub-segment 030603.

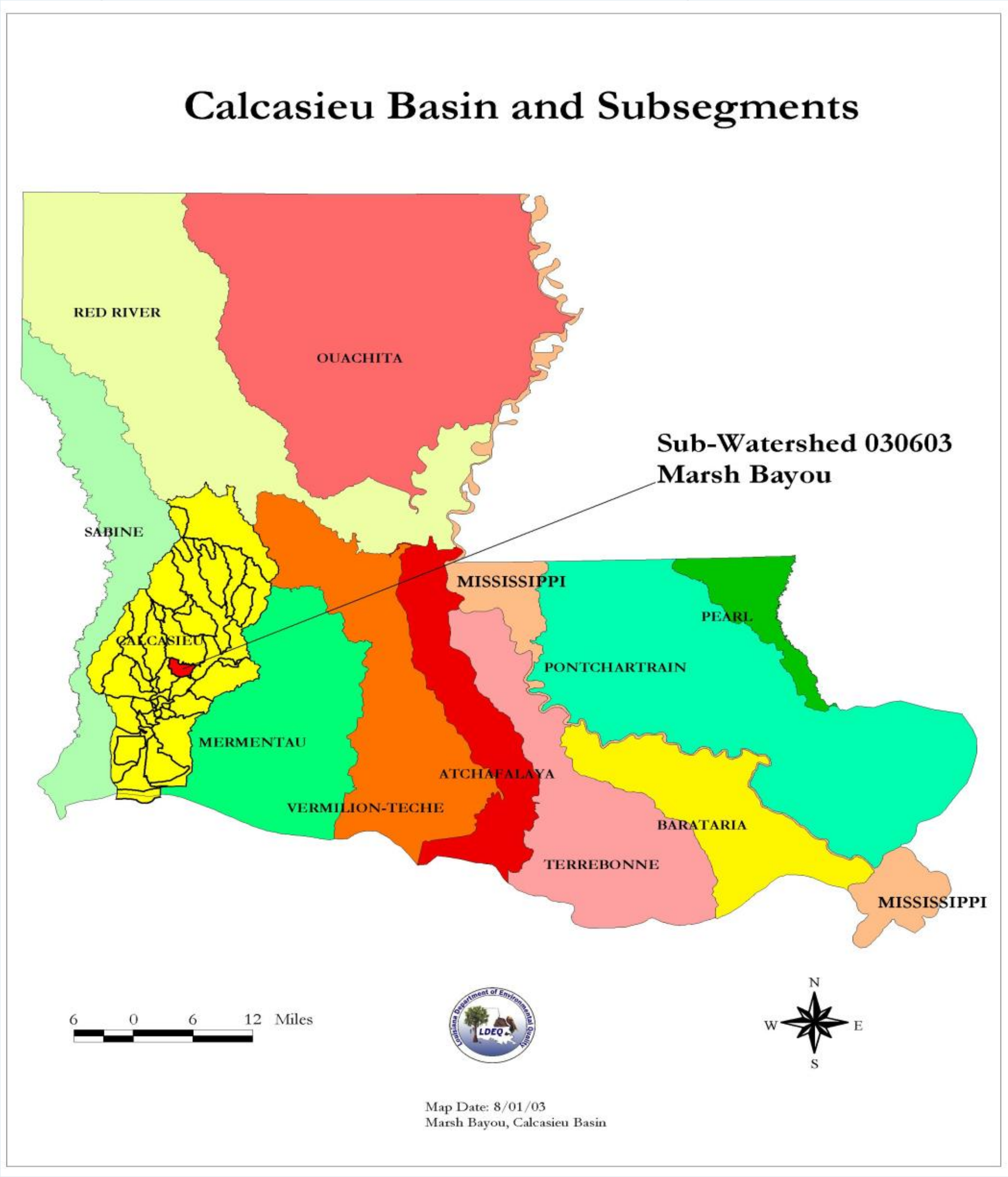


Figure 3: Watercourse in the Marsh Bayou Watershed.

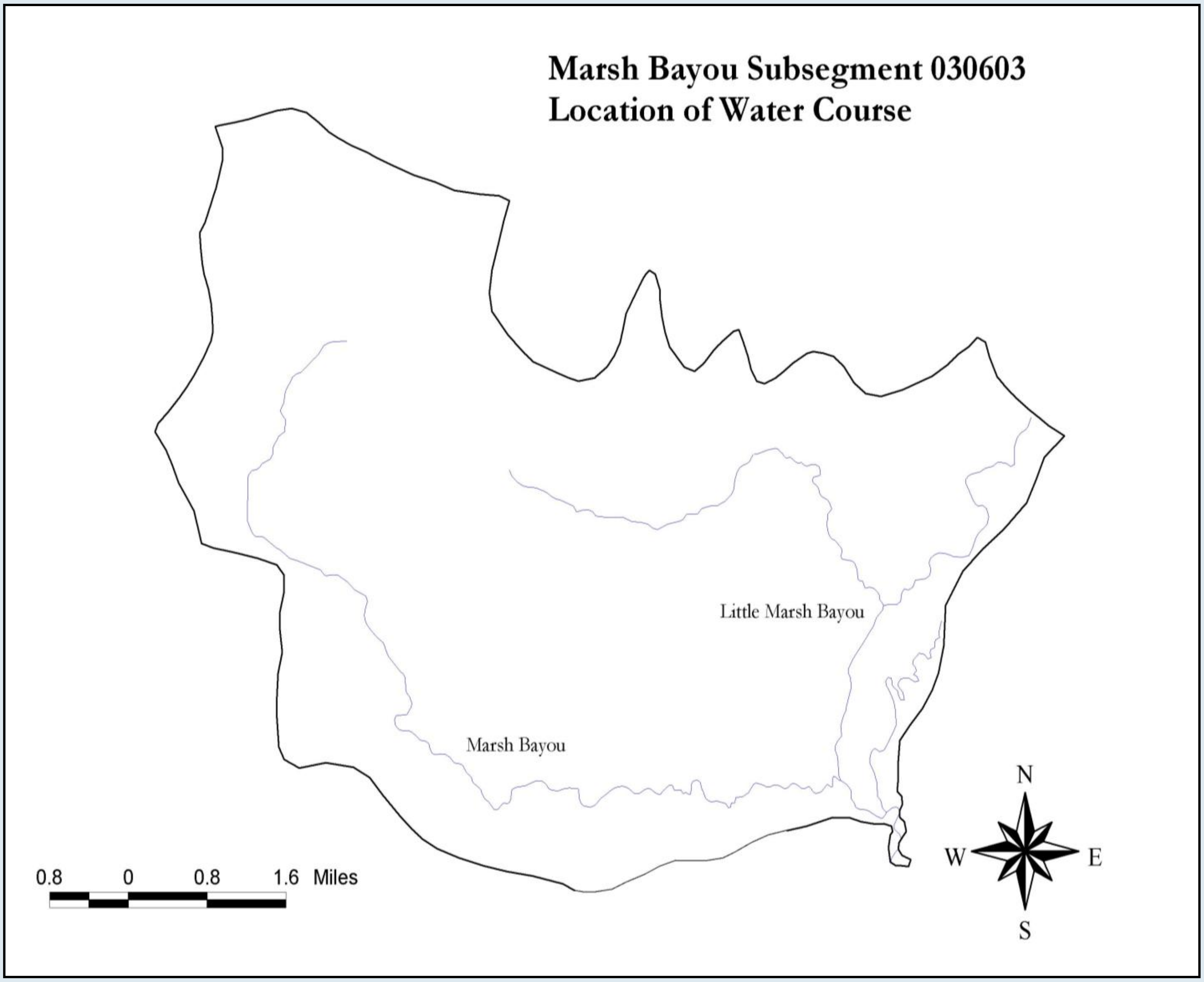
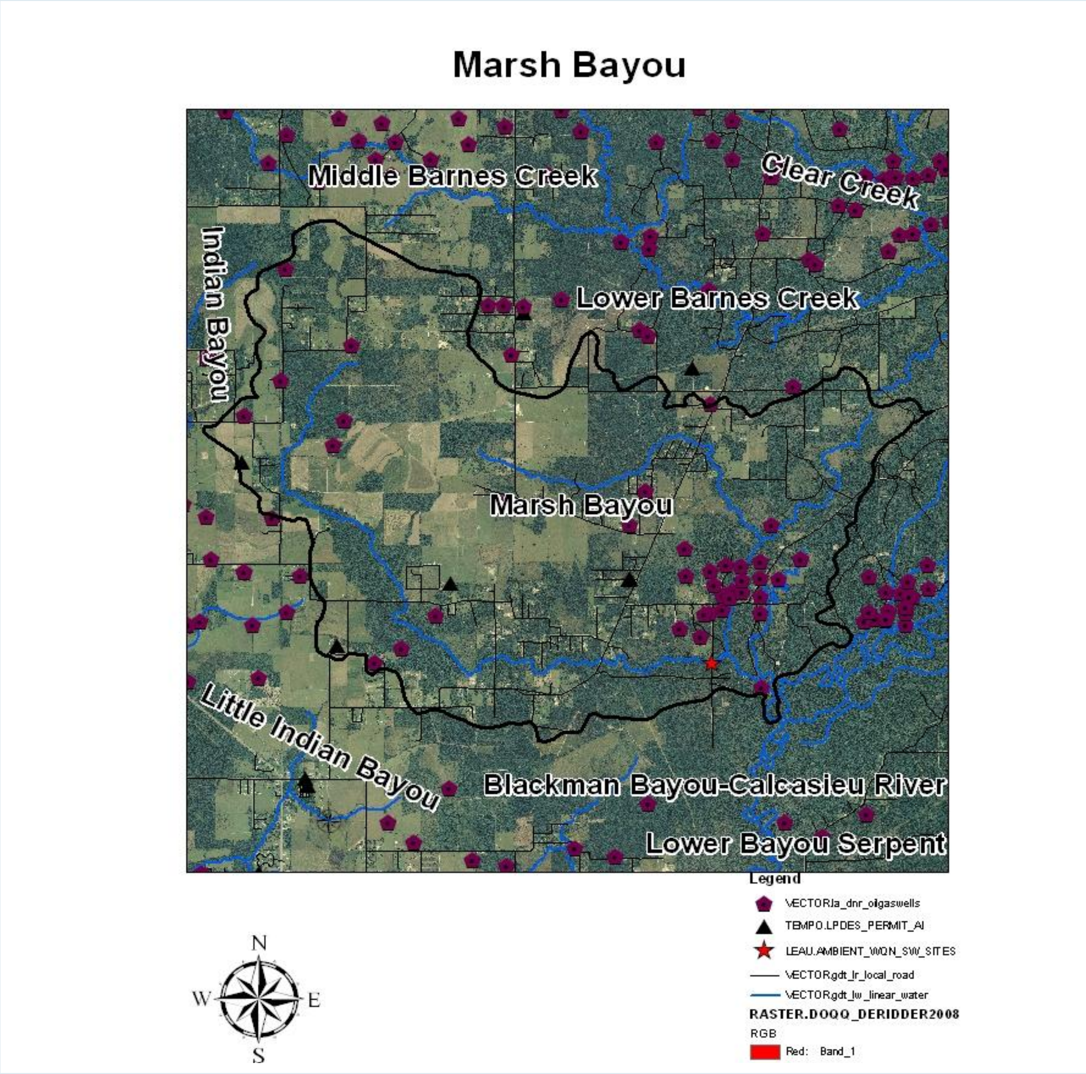


Figure 4: Digital Orthophoto Quarter Quadrangle map of Marsh Bayou Watershed



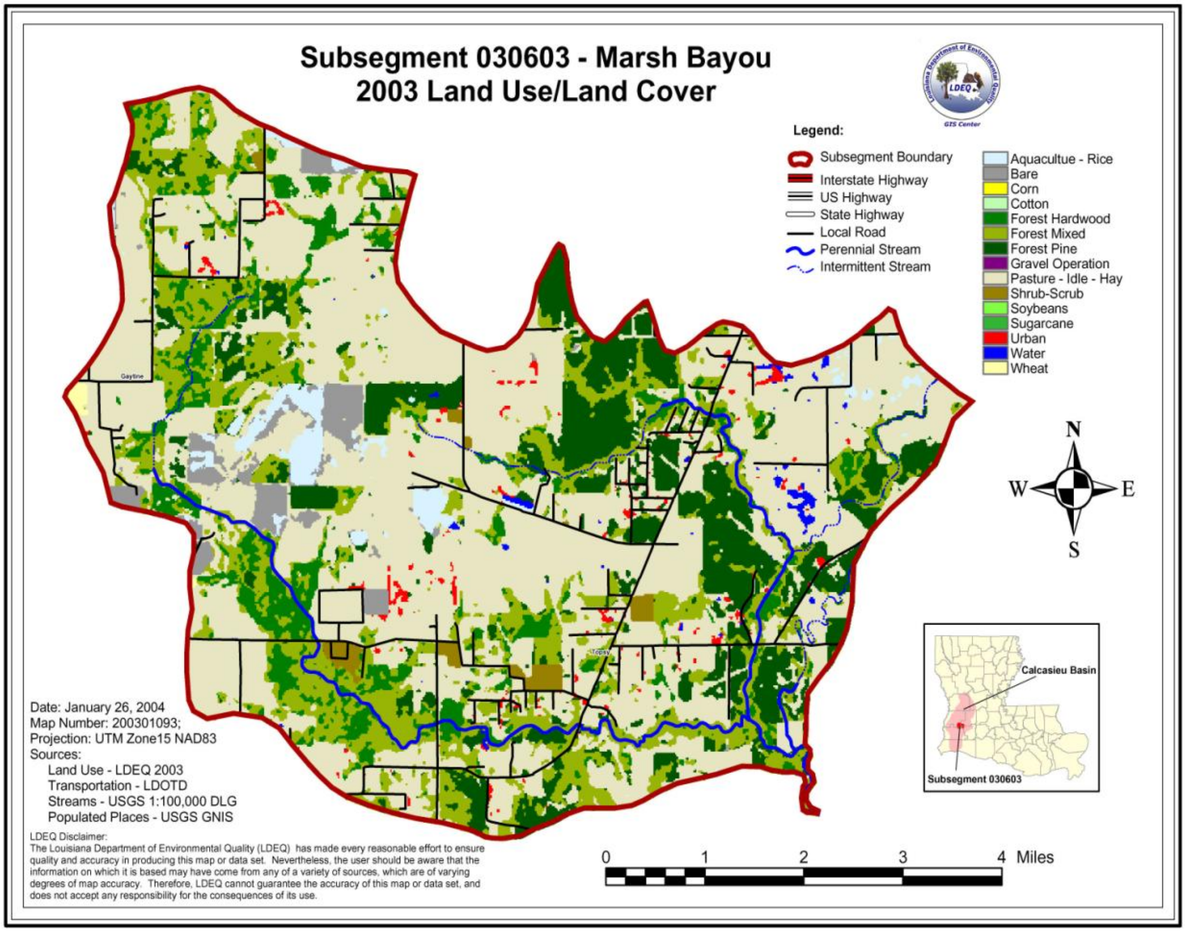


Figure 5: Detailed Land-use Map of Marsh Bayou

1.3 MARSH BAYOU WATERSHED DESCRIPTION

The Marsh Bayou Watershed, Sub-segment 030603 exists within four different parishes Beauregard, Allen, Calcasieu, and Jefferson Davis. Marsh Bayou is the main channel in the watershed where the surface runoff drains to, which carries flow into the Calcasieu River. The main tributary draining into Marsh Bayou is called “Little Marsh Bayou”, along with several unnamed tributaries. Little Marsh Bayou may be the only tributary with a perennial flow, while the other tributaries flow only after significant rainfall events. It drains the eastern portion of the watershed.

The Marsh Bayou Watershed is located in the south-central portion of the Calcasieu River Basin, an area just northeast of Lake Charles, east of DeQuincy, and south of Reaves. Marsh Bayou is a tributary to the Calcasieu River and enters on the right descending bank. The watershed drainage area is approximately 40 square miles, beginning east of Dequincy and flowing southwest for approximately 26 miles to its confluence with the Calcasieu River. The total amount of square acres in the watershed is estimated 24,671. Marsh Bayou is also represented by one 12-digit HUC (080802030703).

The Marsh Bayou Watershed has landscape features that are found in two of the three ecoregions that make up the Calcasieu River Basin, the *South Central Plains* and *Western Gulf Coastal Plain* eco-regions. The watershed is located at a point of transition between the two eco-regions. For example, in the northern portion of the watershed there are higher elevations (80ft to 50 ft above mean sea level) with sharper land contours in the form of upland terraces blanketed by dense stands of mixed pine. The hydrology in the north make up the headwaters to Marsh Bayou, originating as small shaded creeks and springs with small flows draining from north to south. The central portion of the watershed undergoes a transition from higher elevations with sharp contours to lands having gentler slopes and less pine. The hydrology in the central area becomes less diffuse and more defined. The Marsh Bayou descends southward along the western watershed boundary of the watershed to the southern portion. In the southern portion of the watershed, Marsh Bayou makes a “lateral trek” from its western watershed boundary across to its eastern boundary at its confluence with the Calcasieu River. The land throughout this area is much flatter having lower elevations (25 ft to 10 ft above mean sea level) covered by a wide and dense stand of bottomland hardwoods and other lowland species. The bottomland forest, cypress forest, and other streamside vegetation form a “riparian buffer zone” along most all of the bayou on its way to the Calcasieu River. The riparian zone is functioning as the floodplain for the Marsh Bayou and its tributaries.

1.4 WATERSHED LANDUSES (Key Element 1: Sources and Causes of NPS Pollution)

The land uses observed in the Marsh Bayou Watershed are mostly agriculture, forestry, and pastures. Few residential areas and no urban areas exist in the watershed at this time. Most residents are rural and are located near the Town of Topsy in the south-central portion of the watershed. Agriculture is common throughout the watershed particularly in the northern, western, and central portion of the watershed. The types of agriculture activities are rangeland, soybean, rice, and pastureland grazing. Forestry is another common land use activity practiced throughout the entire watershed, particularly where the mixed pine forests are located. Table 1 illustrates the land use type, the amount of acres, and percentage cover in watershed based on the work done by LDEQ's GIS Center in 2003.

Table 1: Land Uses in Segment 030603 of the Marsh Bayou Sub-segment (LDEQ, 02003).

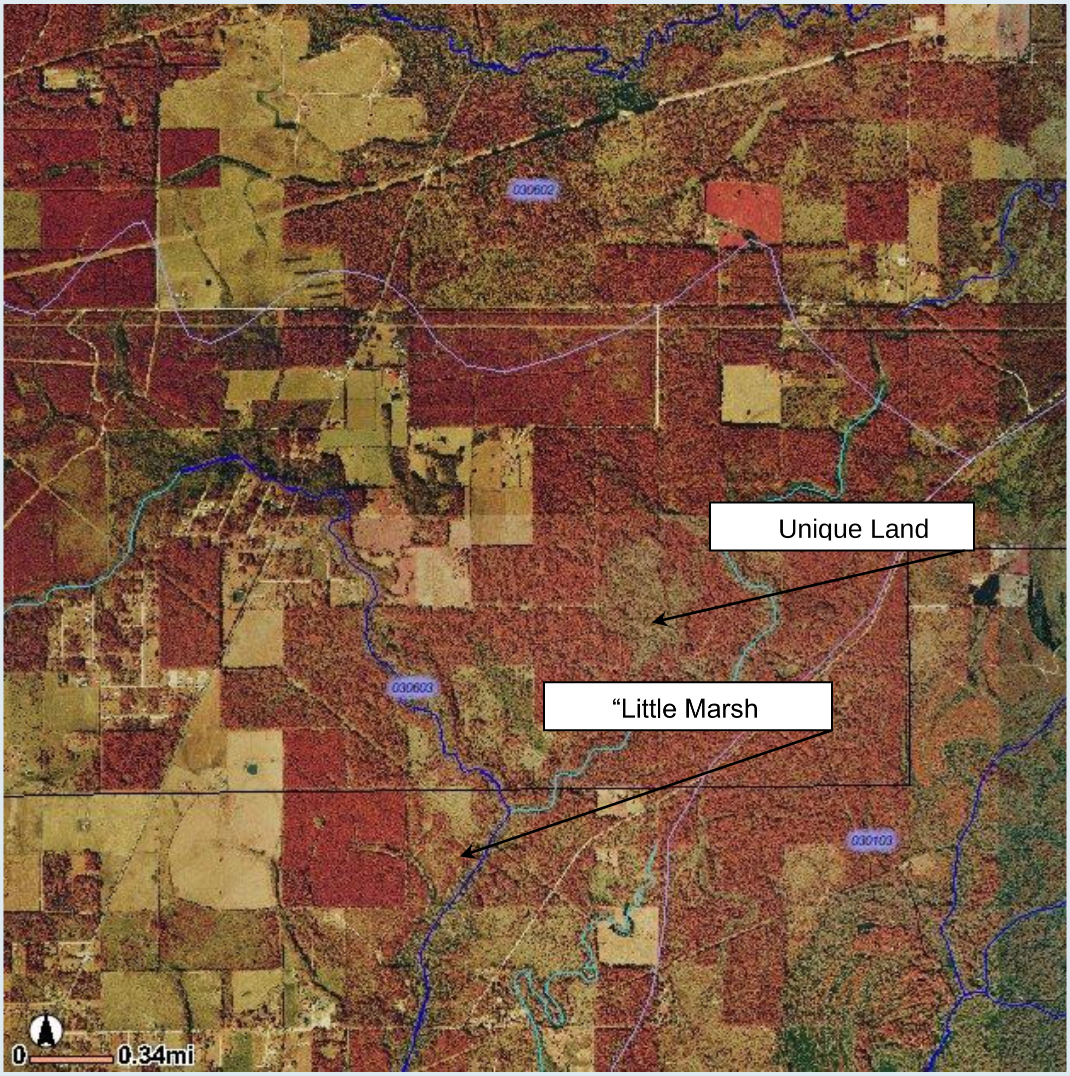
Land Use Type	Acres	Percent %
Urban	211	0.85%
Pastureland	13,466	54.10%
Aquaculture/Rice	536	2.30%
Soybeans	204	0.82%
Forest	9,555	38.38%
Shrub/Scrub	230	0.92%
Water	113	0.46%
Bare Land	572	2.15%
TOTAL	**24, 887**	**100%**

1.5 WATERSHED FIELD SURVEY

A site visit was made to the Marsh Bayou Watershed during the month of May in 2003 in order to conduct a field survey and to make a general assessment of the watershed. Satellite maps in digital orthographical quarter quadrangle DOQQ format were utilized to identify the different types of land uses, their locations, and their percentage of cover in the watershed. With such a high level of detail and resolution, these maps were instrumental for identifying the potential sources of NPS loading in the watershed. Topographical maps and a hand-held GPS (global positioning system, WAAS ed.) were utilized for navigation purposes while verifying the types of land uses.

While traveling through the headwaters of “Little Marsh Bayou”, a tributary to Marsh Bayou located in the northeastern portion of the watershed, a high diversity of plant species was noted. Such unique plant species as Coral Bean Plant, Wild Echinacea, Butterfly Milkweed, and Sassafras were readily observed. Several other unique flowering plants were present within close proximity.

Figure 6: Northeast Portion of the Marsh Bayou Watershed



The landscape in the area of the watershed contained both a mixture of upland species and bottomland species that exist in the same area. The high level of plant species diversity is attributed to the watershed's location within the Calcasieu River Basin. This is an area in the Calcasieu River Basin where two different eco-regions happen to converge. The soils here appeared to have moderately high sand content, which causes them to be highly erosive as indicated by the deepened rills, gullies, and washouts that were present along the local logging road. Just south of this area, in the southeastern portion of the watershed, is the location of several active oil and gas wells.

During the field survey, several stops were made at the bridges crossing Marsh Bayou and its tributaries. At most of these sites, the water level seemed very low, pooling rather than flowing downstream. The area was dry from not having received recent rainfall, which causes the stream channels to appear even smaller and without flow. Additionally, many of the channels were silted-in with sediment. Excessive in-stream sediment is evidenced by the formation of smaller and shallow braided streams, rather than a single defined channel. The bank-full width of the channel was much wider than the “wetted perimeter” indicating that the channel has the capacity to handle much larger volumes of runoff. Most of the banks and floodplains within the watershed were shaded by a healthy riparian buffer system. Some invasive plant species such as Chinese Tallow and Privet were observed growing in the disturbed areas along the tributaries throughout the watershed. Each bridge stop had evidence of excessive dumping of trash into the waterway. Though mostly domestic waste, items ranged from old refrigerators to washers, a basketball goal, tires, large plastic trash bags, construction debris, crawfish hulls, etc. As a result, the aesthetic value at these sites was decreased and the flow was restricted.

Most of the in-stream channels of Marsh Bayou and its tributaries contained high amounts of woody debris and natural organic material such as fallen trees, branches, and limbs. The trees, branches, and limbs appeared to be deposited both locally and from upstream sources. Increased bank scour has resulted in many local fallen trees and debris. Branches and deposits of other woody debris are present throughout the floodplains along the channels appearing to have been carried and deposited from upstream sources during high flow periods.

A follow-up site visit was made to the Marsh Bayou Watershed during the month of November in 2009 in order to assess the area again. At the Topsy Bell road bridge crossing near Little Marsh Bayou, little or no flow was observed in the waterway. There was evidence of dumping of trash into the bayou. Items ranged from televisions to lawn mowers. Oil was also observed in the bayou.

Image 1: Little Marsh Bayou @ Topsy Bell Road downstream (Domestic Trash, Litter and Debris)

Image 2: Little Marsh Bayou @ Topsy Bell Road downstream (Oil in the Bayou)

In Jefferson Davis Parish there has been some new residential urban/rural development. This parish is mostly a wooded area. Potential erosion along the ditches was observed. It was noted by the SWCD representative that no BMPs in this area have occurred.

Image 3: Marsh Bayou @ Welcome Road Bridge Crossing (Possible Erosion)

Woody debris was found in Marsh Bayou at Joe Sonnier Memorial Bridge. There was evidence of some flow here. At the Welcome Road Bridge crossing, even more litter in the bayou was seen. There were tires, sinks, toilets, and even a deer carcass. Erosion was observed on the side of the road near the ditches. The water in the bayou appeared cloudy with foam floating on top. This could have been evidence of possible construction.

Image 4: Marsh Bayou at Joe Sonnier Memorial Bridge (Woody Debris)

Image 5: Marsh Bayou @ Welcome Road Bridge Crossing (Domestic Trash, Litter and Debris)

Image 6: Marsh Bayou @ Welcome Road Bridge Crossing (Foam in the Ditch)

On Briar Marsh Road near Marsh Bayou, home septic systems were in use. A pipe draining directly into the ditch was noted in the parish of Beauregard. Septic tank maintenance is not enforced which could be a possible cause of high fecal coliform levels. In order to see what impact that the watershed currently has on the water quality in Marsh Bayou, LDEQ analyzed the water quality data that they had collected during 1999, 2005 and 2008/2009. The results of these data are presented and described in Section 2.0 of this plan.

Image 7: Marsh Bayou on Briar Marsh Road (Septic System with pipe draining into the ditch)

Many rice farms as well as soybeans were observed in the watershed. During the months of November through June the rice fields are used for Crawfish farming. Beauregard Parish has a good deal of BMP practices in place. Tables 6, 7, and 8 have been included which show the parishes of Allen and Beauregard and the BMPs that are currently in use.

2.0 WATER QUALITY DATA

Water Quality samples were collected and analyzed during 1999, 2005, and 2008/2009 from the LDEQ sampling site number 0839 on Marsh Bayou at a point southeast of the town known as “Topsy” in Jefferson Davis Parish. The water quality test results showed that seven out of twelve months had dissolved oxygen levels less than 2.0 mg/L in the water during 1999, six out of nine months in 2005, and five out of seven months in 2008/2009 (Chart 1). The water quality standard for dissolved oxygen in Marsh Bayou is 5.0 mg/L all year. The following graphical illustration, of the seasonal trends for dissolved oxygen exhibits periods of lower oxygen occurring during the summer months (See Chart 3). As water temperatures increase, the levels of dissolved oxygen decrease. These low oxygen periods coincides with the months of the year known for having the highest temperatures and least amounts of water flow.

Chart 1: Seasonal Trend of Dissolved Oxygen in Marsh Bayou during 1999-2009.

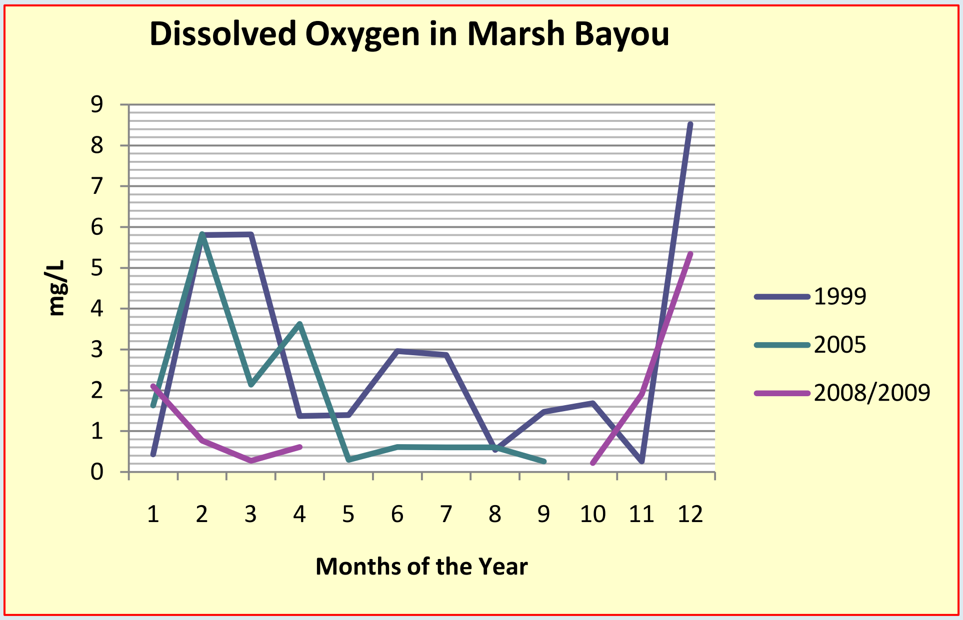


Chart 2: Seasonal Trend of Water Temperatures in Marsh Bayou during 1999-2009.

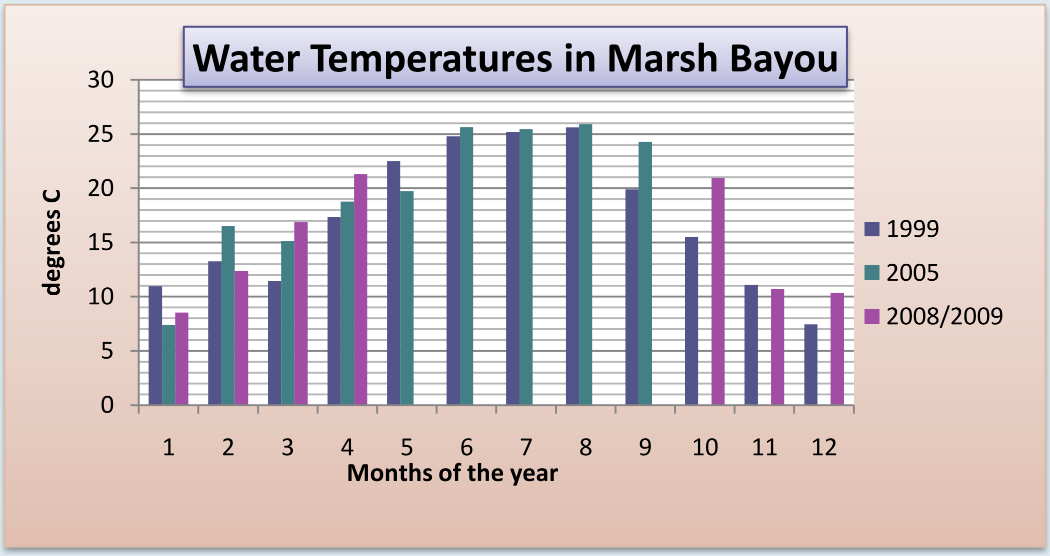
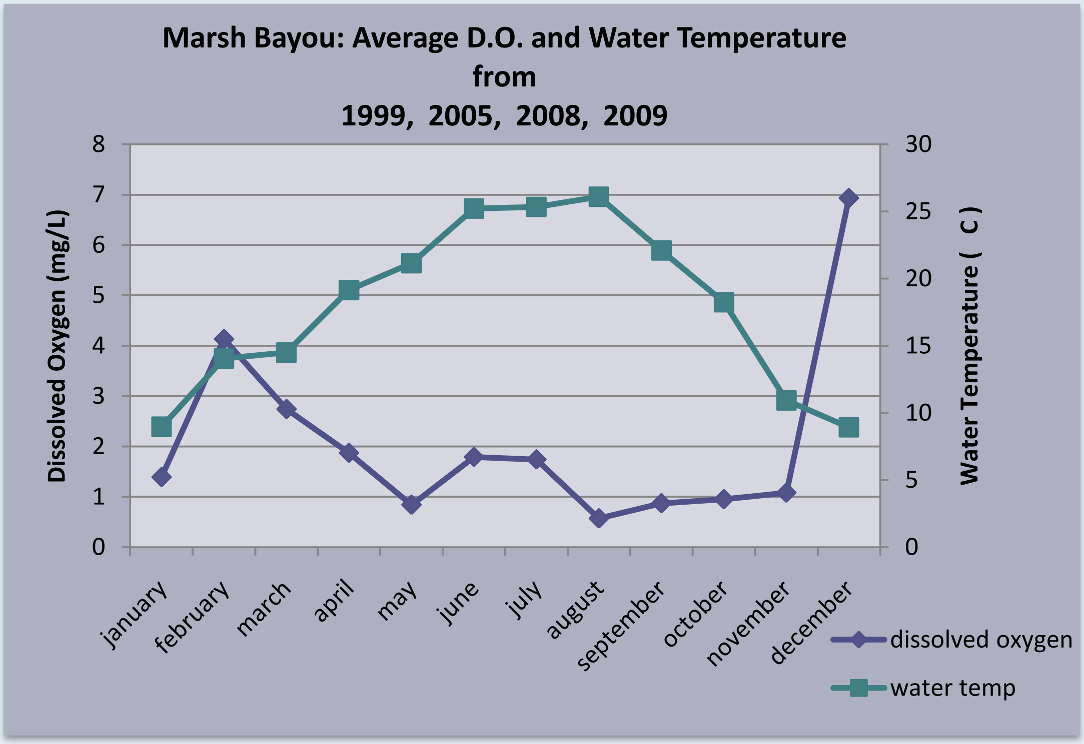
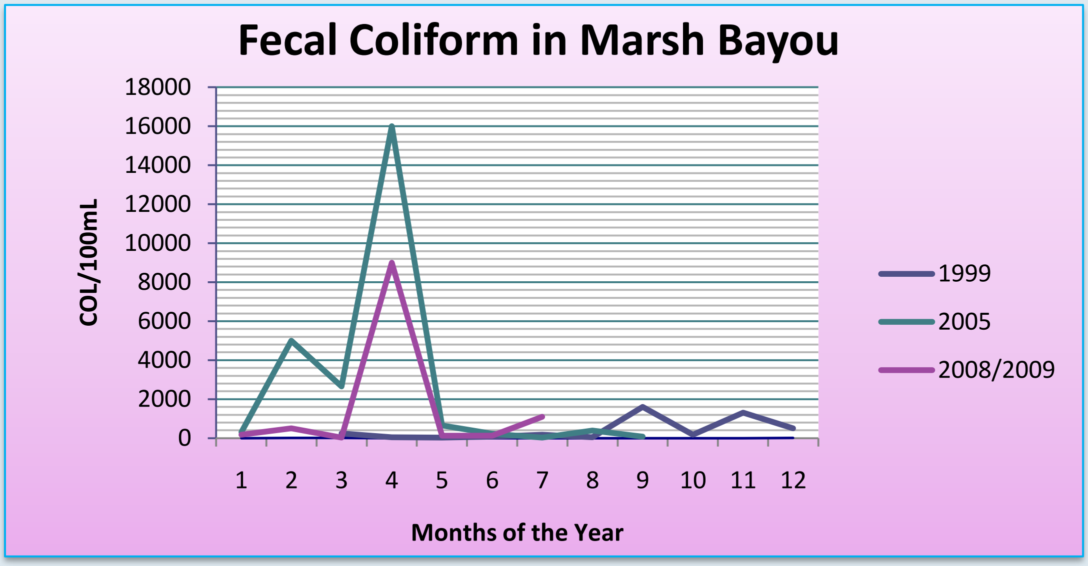


Chart 3: Seasonal Trend of Average D.O. and Water Temp. in Marsh Bayou during 1999-2009.



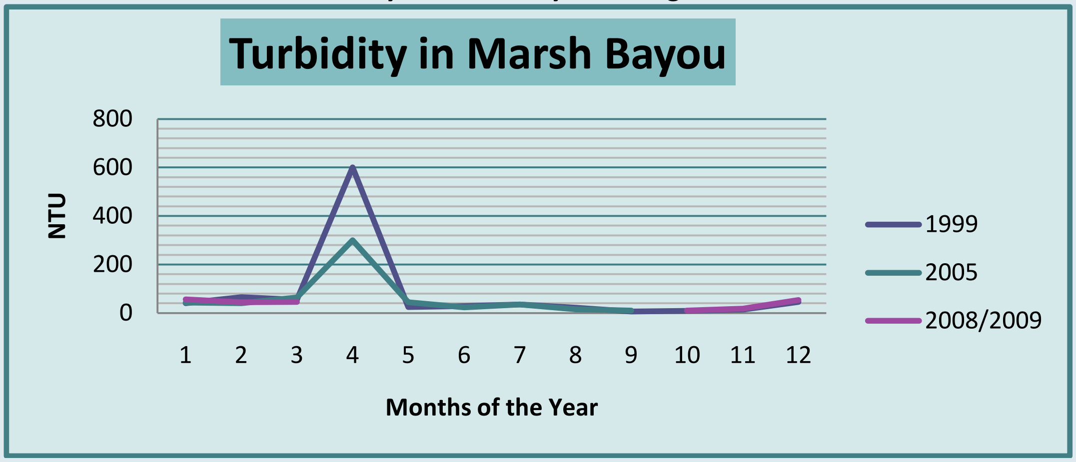
Fecal coliform is now a big problem in the Marsh Bayou watershed. According to the data collected the values seemed to have spiked during certain times of the year. In April of 2005 the fecal coliform level was 16000 COL/100mL and in April of 2009 the value was 9000 COL/100mL. (Chart 4) The large spike in April is not within the swimming season of May-October, but these values exceed the water quality standard for the secondary contact recreational use, which is applied for the entire year. A TMDL was completed for fecal coliform bacteria by EPA and it indicated that in order to meet water quality standards, that there would need to be 82% reduction in fecal coliform bacteria during the winter months and 98% reduction during the summer months.

Chart 4: Seasonal Trend of Fecal Coliform in Marsh Bayou during 1999-2009.



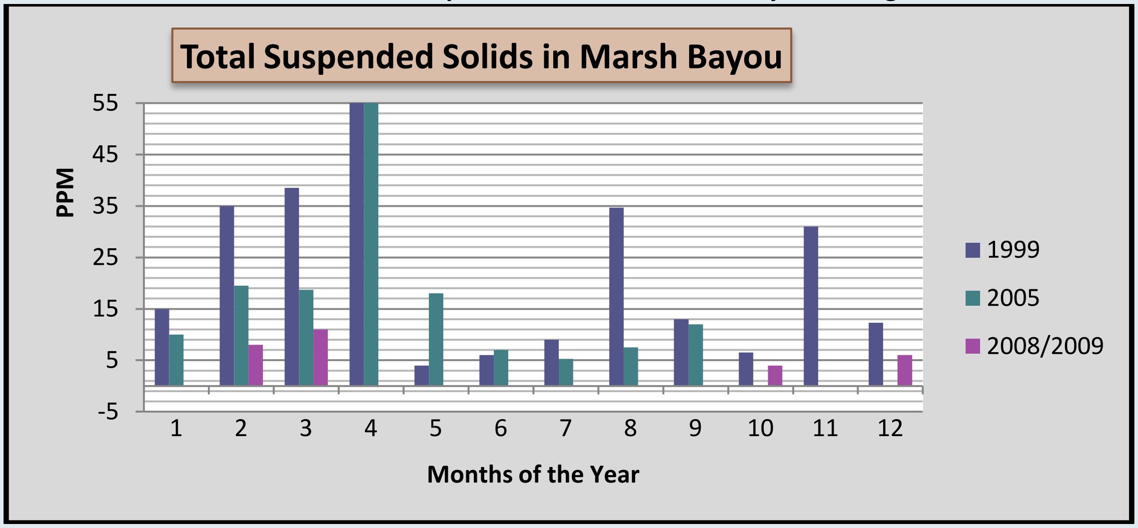
The values for the turbidity in Marsh Bayou seemed to spike at similar times as the values for fecal coliform. Again April seems to be the month where most of the water pollution occurs. In April of 2009 the turbidity level was 600 NTU and in April of 2005 the value was 300 NTU. The lowest value for turbidity seemed to have occurred in September of 2009 which was 6.4 NTU. (Chart 5) The water quality standard for turbidity recommends a value of 50 NTU for the Calcasieu River. This is a guideline for water bodies in this part of the state.

Chart 5: Seasonal Trend of Turbidity in Marsh Bayou during 1999-2009.



The graph below represents the data for TSS (Total Suspended Solids). TSS seemed to be highest during the month of April. In April of 1999 the value for TSS was 151ppm and in April of 2005 the value was 78ppm. There seems to be an ongoing trend of water pollution in the bayou during the month of April. TSS values that were reported in the cooler months were much lower. In October of 2008 the value was 4ppm. (Chart 6)

Chart 6: Seasonal Trend of Total Suspended Solids in Marsh Bayou during 1999-2009.



The next two graphs (Charts 7 and 8) below represent data collected for nitrogen. April 2005 and April of 2009 had the highest values for kjeldahl nitrogen (4.27ppm and 7.33ppm respectively). The highest value for nitrate-nitrite nitrogen was in August 2009 (0.3ppm). Values were lower in the cooler months for both nitrate-nitrite nitrogen (0.9ppm in February 2005, December 2008 and March 2009) and kjeldahl nitrogen (0.02ppm in January and March of 2009).

Chart 7: Seasonal Trend of Nitrogen, Kjeldahl in Marsh Bayou during 1999-2009.

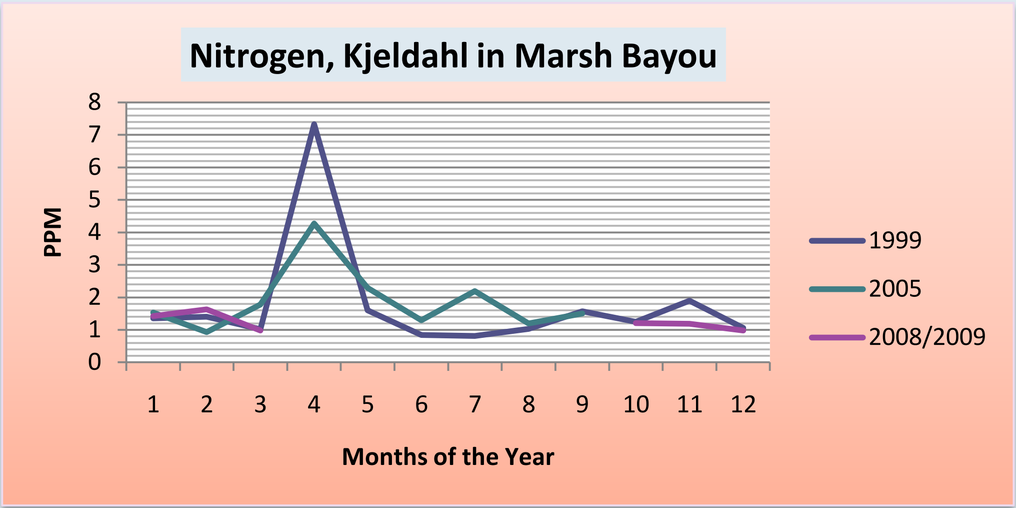
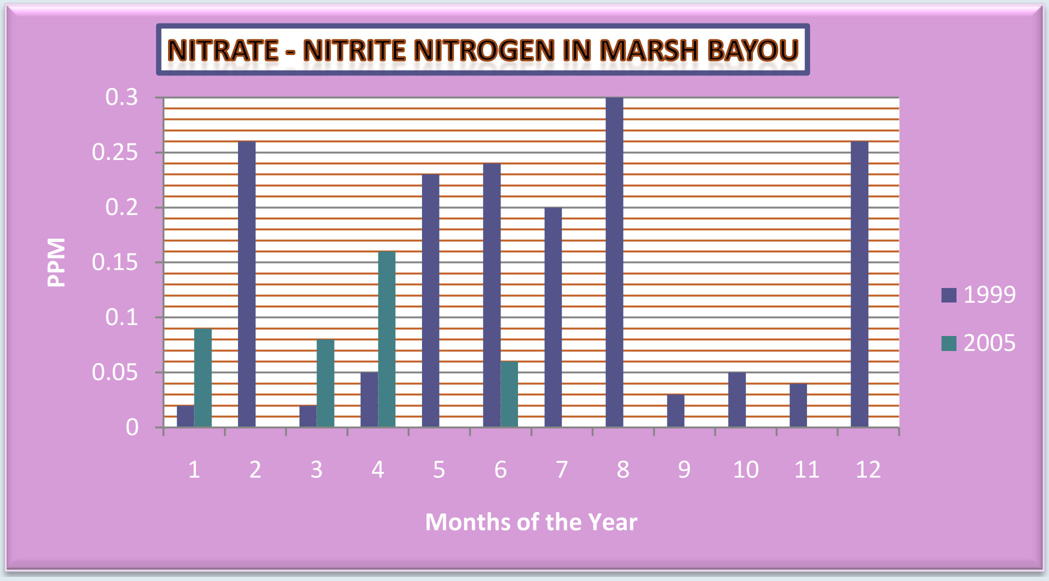


Chart 8: Seasonal Trend of Nitrate – Nitrite Nitrogen in Marsh Bayou during 1999-2009.



An explanation to the poor water quality test results occurring during the month of April could be attributed to a flush of pollutants from smaller streams and tributaries occurring after a heavy rainfall event. During times of drought, pollutants tend to accumulate in smaller streams and tributaries to Marsh Bayou. At that time, pollutants may never make it to Marsh Bayou. However, during the springtime of the year when higher rainfall amounts are most common, heavy rainfall can cause streams that didn't have a flow to reach a "bank-full" water level. Bank-full water levels produce enough hydraulic energy and shear stress to flush accumulated pollutants downstream, into Marsh Bayou. Another explanation could be that it is the peak time of year when a particular type of land use activity occurs, or a combination of both. The types and distribution of land uses in the Marsh Bayou Watershed is described and evaluated in the following Section 4.

3.0 TOTAL MAXIMUM DAILY LOAD (TMDL) and FINDINGS

In order to address the impaired designated use of "fish and wildlife" propagation for Marsh Bayou, the amount of dissolved oxygen (DO) in the bayou needs increasing. The amount of fecal coliform in the bayou needs decreasing. A TMDL for fecal coliform has not been done yet. TMDLs are required to be developed by Federal Clean Water Act in order to establish an upper limit for the amount of pollutant loading a designated water of the state can handle and still meet its designated uses. Reducing the amount of oxygen consuming substances entering the bayou can raise the level of DO. LDEQ watershed engineers utilized a "stream model" to simulate the conditions of the Marsh Bayou waterway in order to determine a Total Maximum Daily Load of pollutants it can handle and still meet numerical water quality standards.

Total Maximum Daily Loads (TMDLs), are the maximum amount of a pollutant that can be discharged into a water body without causing the water body to become impaired and/or violate state water quality standards. TMDLs are defined in 40 CFR Part 130 as the sum of the individual Waste Load Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint sources, including a margin of safety (MOS) and natural background conditions, i.e. TMDL Allocation = WLA + LA + MOS. The stream model utilizes parameters such as channel dimensions, channel length, channel slopes etc. based on data obtained on a "reference stream" (un-impacted stream) surveyed from the same area to simulate the bayou. LDEQ utilizes a "conservative approach" when determining the TMDL for Marsh Bayou by using the "7Q10 Flow Rate. The 7Q10 flow rate represents the lowest flow values occurring seven days straight within a ten-year period of time. It is known that low rates of flow do not offer much dilution of pollutants; therefore, meeting the water quality standards at these flow levels is difficult.

The TMDL was prepared on May 25, 2001 and revised on September 24, 2001 by LDEQ for the Marsh Bayou Watershed, sub-segment 030603 to address the low dissolved oxygen levels. A water quality model (LA-QUAL version 4.0 steady-state one dimensional) was used to determine the TMDL for the bayou. Marsh Bayou was modeled from its headwaters to its confluence with the Calcasieu River. The model provided data on how much pollutant loading a waterway can handle based on data that was input into it. The input data helped the model to simulate stream conditions when the TMDL was determined. LDEQ took a "conservative approach" when the model was used to determine the TMDL. The headwater flow, measured during "sub-critical flow conditions" (7Q/10) was input to model as the representative flow for the entire bayou. Critical flows often occur when temperatures are highest, which also causes low dissolved oxygen levels in the bayou.

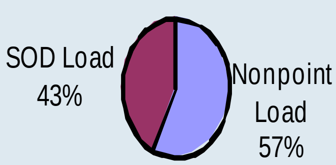
One should note that the critical conditions may not be representative of actual stream conditions for the majority of the time, but this is when the TMDL should be met. Additionally, a 20% "margin of safety" was added to the TMDL to account for current and future man-made sources of pollution. Based on LDEQ permit data, there were no facilities known to be discharging into Marsh Bayou or any of its tributaries. Therefore, the water quality impairment of Marsh Bayou is attributed to nonpoint source loading.

Water sampling for development of the Marsh Bayou Watershed TMDL was conducted on June 13 – 15, 2000. Sites sampled included:

1. Calcasieu River below confluence of Marsh Bayou;
2. Marsh Bayou @ confluence of Calcasieu River
3. Marsh Bayou Road
4. Topsy Road
5. Welcome Road

The data collected included pH, temperature, dissolved oxygen, conductivity, field secchi disc, salinity, TSS, TDS, chlorides, sulfates, sodium, hardness, nitrate+nitrite nitrogen, total phosphorus, TKN, Ammonia, TOC, total nitrogen, and total nitrogen/total phosphorus.

Figure 7: TMDL Load Distribution of Oxygen Demanding Substances for Marsh Bayou Watershed.



According to the TMDL Report, the dominant oxygen demanding load in the watershed at low flow was from an accumulation of benthic material washed into the streams during a period of higher flow. This load was exerted as "sediment oxygen demand" (SOD) and as resuspension of material from the bottom. The suspected cause of the designated use impairment in Marsh Bayou watershed was from the accumulation of benthic materials (material on bottom of stream channel) washed into the stream during periods of higher flows (LDEQ TMDL Revised 2001).

For modeling purposes, Marsh Bayou was divided into 15 reaches (Table 2). Model results showed the load distribution of oxygen consuming substances for each different reach (Figure 7). All of the reaches showed high levels of SOD, particularly in reach 9, which appeared to have the SOD amount, which could be attributed to a Beaver Dam located at reach 10. Reach 15 near the confluence of Marsh Bayou and the Calcasieu River exhibited the least SOD load. This could possibly be influenced by a dilution factor from the Calcasieu River.

Table 2: Reach Descriptions.

Reach Number	**Reach Description**	**Calibration Model Reach Length (km)**	**Ending River Kilometer of Reach**
1	Marsh Bayou, E. Welcome Rd. – Rkm 8.6	0.92	
2	Rkm 8.6 to unnamed tributary on left descending bank (LDB)	1.00	1.92
3	Unnamed tributary (UT) LDB to Site 4	0.95	2.87
4	Rkm 6.65 – E of Topsy	0.65	3.52
5	East of Topsy Rd. – Rkm 5.2	0.80	4.32
6	Rkm 5.2 – UT on LDB	1.00	5.32
7	UT on LTB to Site 3	0.90	6.22
8	Site 3 to Little Marsh Bayou	0.50	6.72
9	Little Marsh Bayou to Beaver Dam	0.25	6.97
10	***Marsh Bayou Beaver Dam***		
11	Beaver Dam to Rkm 2.0	0.55	7.52
12	Rkm 2.0 to UT LDB	0.40	7.92
13	UT LDB to Natural Diversion – Calcasieu River	0.30	8.22
14	Natural Diversion to Calcasieu River 0.2	0.50	8.72
15	Marsh Upper Outlet to Lower Outlet	0.80	9.52

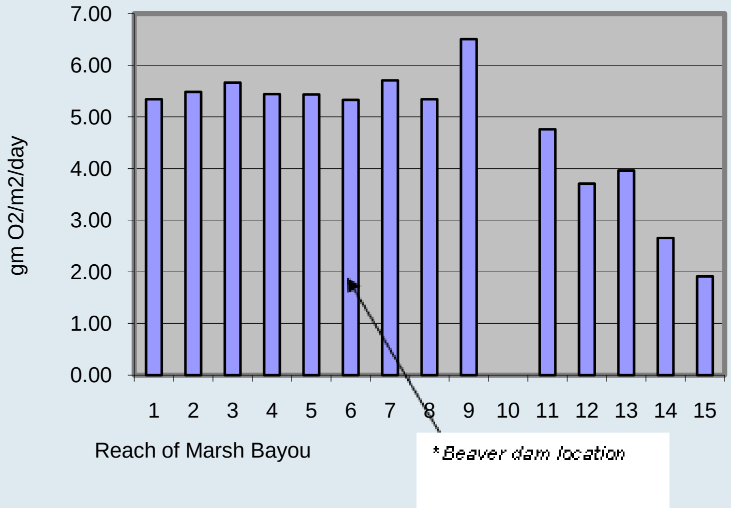


Chart 9: TMDL Model results showing the Distribution of SOD Load for each different reach of Marsh Bayou

The TMDL report indicated that the largest contributing nonpoint source load in Marsh Bayou Watershed is the benthic load, which is comprised of organic material that has accumulated on the bottom of the bayou. Benthic material utilizes the dissolved oxygen that exists in the water column for biochemical degradative processes, otherwise referred to as "SOD" (sediment oxygen demand).

The TMDL modeling results demonstrated that the total nonpoint load must be reduced by approximately 67 % in order to meet the existing stream criterion for dissolved oxygen DO (5.0 mg/L).

Once the TMDLs were developed and the NPS load indicated that there would need to be a 67% reduction in order to meet water quality standards, LDEQ utilized the AnnAGNPS watershed model to identify "hot spots" that contribute the largest amount of sediment, nutrients and organic material to Marsh Bayou. The results of that modeling are presented here.

4.0 IDENTIFYING HIGH PRIORITY AREAS IN THE MARSH BAYOU WATERSHED

LDEQ utilized a model called Annualize Agriculture Nonpoint Source (AnnAGNPS), a Natural Resources Conservation Service (NRCS) sponsored model, to evaluate current sediment loadings in the watershed. The model produced results on sediment, phosphorus, nitrogen, and organics as the constituents traveled overland, through the reaches and out the watershed outlet. The results of the model were based on factors such as soil types and distribution including soil k-factor (erodibility), soil LS-factor (land slope), and yearly average rainfall. The model divided the watershed into cells (land area representations) that were used to provide land area boundary as one homogeneous unit. The physical and chemical constituents were routed from their origin within the land area and were either deposited within the stream channel system or transported out of the watershed. Pollutant loadings could then be identified at their source and tracked as they move through the watershed system.

4.1 SOILS

Erosion of soil and transportation to water bodies can cause a plethora of water quality problems. The addition of soil to surface water can decrease the amount of light reaching submerged vegetation, which is known for adding in-stream oxygen. Excessive sedimentation can aggrade stream channels causing a damning or pooling effect, which reduces stream flow. Such conditions are conducive of stagnant waters and poor water quality. Chemicals such as pesticides, fertilizers, and metals are often attached to soil particles and can become transported to water bodies. These chemicals have the potential to directly harm aquatic species in addition to reducing the amount of dissolved oxygen in the stream.

Knowledge of soil types and their locations in the watershed can be helpful when determining where there is greater need for requiring best management practices to protect water quality. Some soils tend to erode more than others do based on their content of sand, silt, and clay. Sensitive areas of land are those containing erosive soils located near waterways and tributaries. They can contribute chronic NPS sediment loading. The following table shows the types of soils in the Marsh Bayou Watershed, their erodibility-factor (the higher factor the higher probability of erosion), fertility levels, and their infiltration rates based on whether they flood or not. A complete list of each different type soil in the Marsh Bayou Watershed can be gathered from Parish Soil Surveys. The watershed is comprised of four different parishes.

Table 3: Common Soil Types in Marsh Bayou Watershed

Symbol	Name	Erodibility (K-Factor)	Fertility Level	Flooding
AcB	Acadia	0.32 – 0.49	Low	No
BzA	Brimestome	0.43 – 0.49	Low	No
CdA	Caddo	0.37 – 0.43	Low	No
GnB	Glenmora	0.49 – 0.43	Low	Rarely
GtB	Guyton Silt	0.37 – 0.43	Low	Sometimes
GYA	Guyton-Ouchita	0.43	Low	Frequent

4.2 Soil Erodibility K-Factor

When planning for soil conservation and water management, it is important to understand that all soils are not the same and that some are more susceptible to erosion than others. The Revised Universal Soil Loss Equation (RUSLE) can be used to predict soil loss and the effectiveness of management practices. One of the factors used in the RUSLE is the K-factor. Erosion K-factor indicates the susceptibility of a soil to sheet and rill erosion by water. Values for K range from 0.02 to 0.64 with the soils that have higher values being more susceptible to sheet and rill erosion. In Marsh Bayou Watershed, K values range from 0.32 to 0.49 with the highest values typically in the higher elevations, the headwaters, and the tributaries.

4.3 Land Slope Length and Steepness Factor (LS-Factor)

An important tool for determining the effect of topography and land elevation on soil loss is the slope length and steepness factor (LS factor). LS values are not absolute values, but represent the ratio of soil loss in a specific area to a value of 1.0 that is given to a slope with 9% steepness and is 72.6 ft long. LS factors are utilized as part of the RUSLE soil erosion equation and can be generated by AnnAGNPS for each cell to determine areas that have high potential for soil erosion. LS values in Marsh Bayou Watershed range from 0.1 to 2.3 (Figure 6) with the highest values tending to be near the headwaters and tributaries.

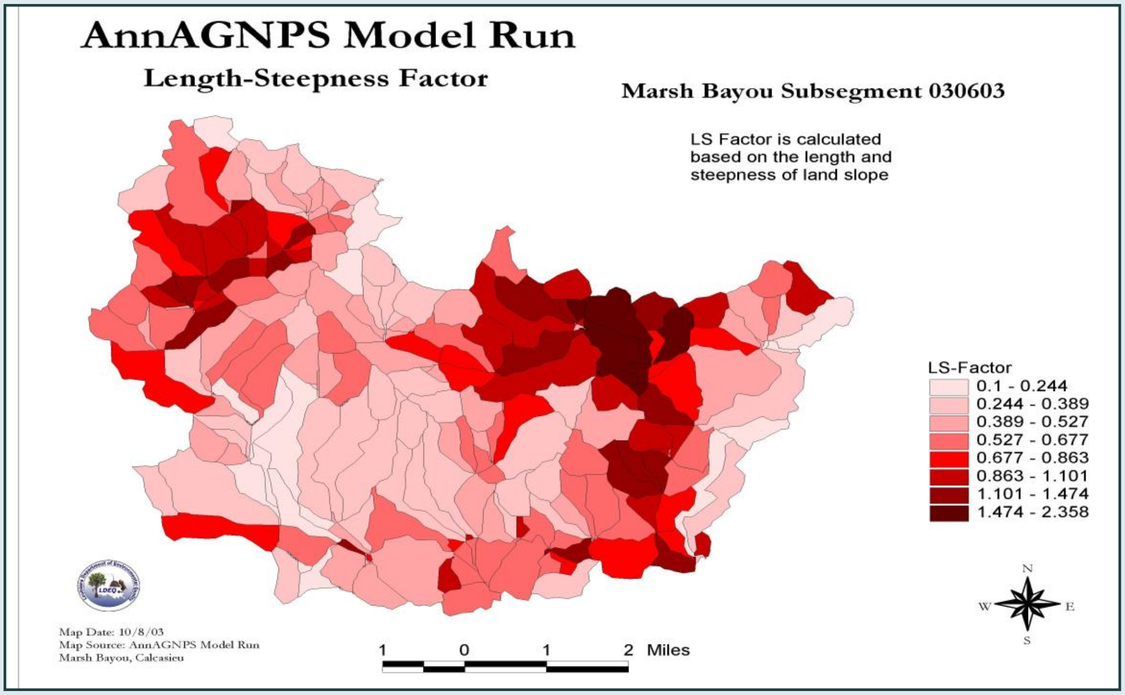


Figure 8: Length-Steepness Factor for Marsh Bayou

As the figure illustrates, the darker colors indicate the parts of the watershed that have the longest and steepest slopes. Within this watershed, this factor makes a difference in how the sediment and nutrients are transported from the land to the bayou. This figure combined with the other figures allows the local soil and water conservation district staff to see which acres within the watershed should be treated with BMPs for soil erosion and nutrient management in order to reduce the pollutant load entering the bayou.

4.4 Sediment Run-Off

Sediment run off within a watershed is principally related to the land-use type, the land slope (LS Factor), the soil erodibility (K-Factor), and the rainfall intensity. These variables are the most significant factors affecting agricultural NPS pollution. The AnnAGNPS model estimates three general types of soil erosion: sheet, rill, and gully. In AnnAGNPS, sheet erosion is considered to move uniformly from every part of the watershed land cell. Rill and gully erosion create small or large ravines by undermining and downward cutting of soil. Gully erosion is larger and more pronounced rill erosion. Gullies eventually produce ditches or ravines exposing subsoils to erosion. AnnAGNPS estimates sheet, rill, and gully erosion for each cell. The results for sediment erosion (figure 10), sediment load (figure 11), and sediment yield (figure 12) indicate where these activities are most likely to occur.

The AnnAGNPS model produces sediment loss by particle size class and source of erosion and divides the runoff into 3 categories: Sediment Erosion, Sediment Yield, and Sediment Load. Sediment Erosion is the amount of sediment that travels overland to the edge of the cell. Sediment Yield is the amount of sediment that is deposited into the stream. Sediment Load is the amount of sediment that travels through the stream network and out the outlet (figure 9). The results are rendered in standard tons/acre/year. Similarly, the model produces runoff and loading for nitrogen, phosphorus, and organic carbon. The nutrient and organic results are provided in lbs/acre/yr (Table 3).

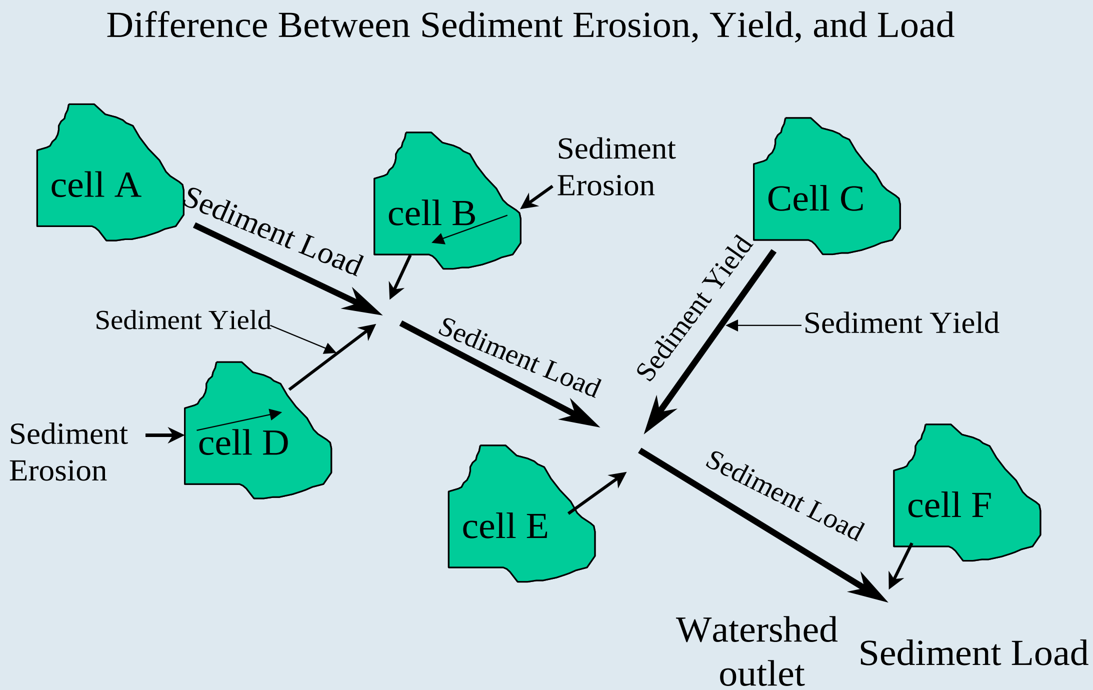


Figure 9: AnnAGNPS Illustration of Sediment Erosion, Load, and Yield

Figure 10: Sediment Erosion in Marsh Bayou Watershed

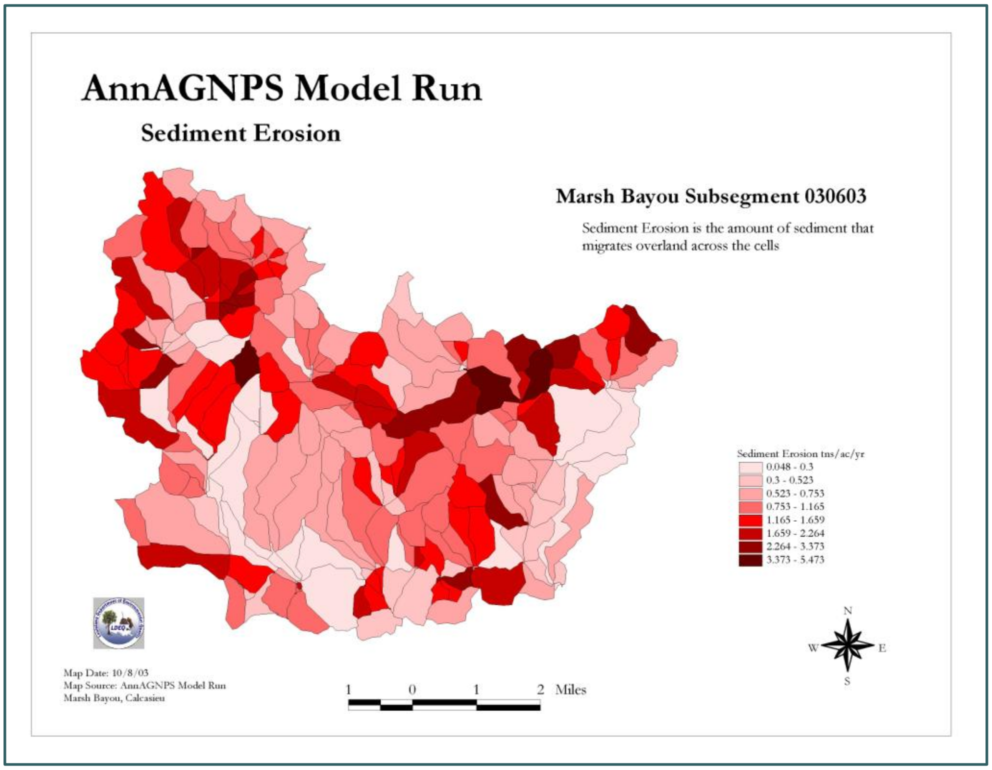
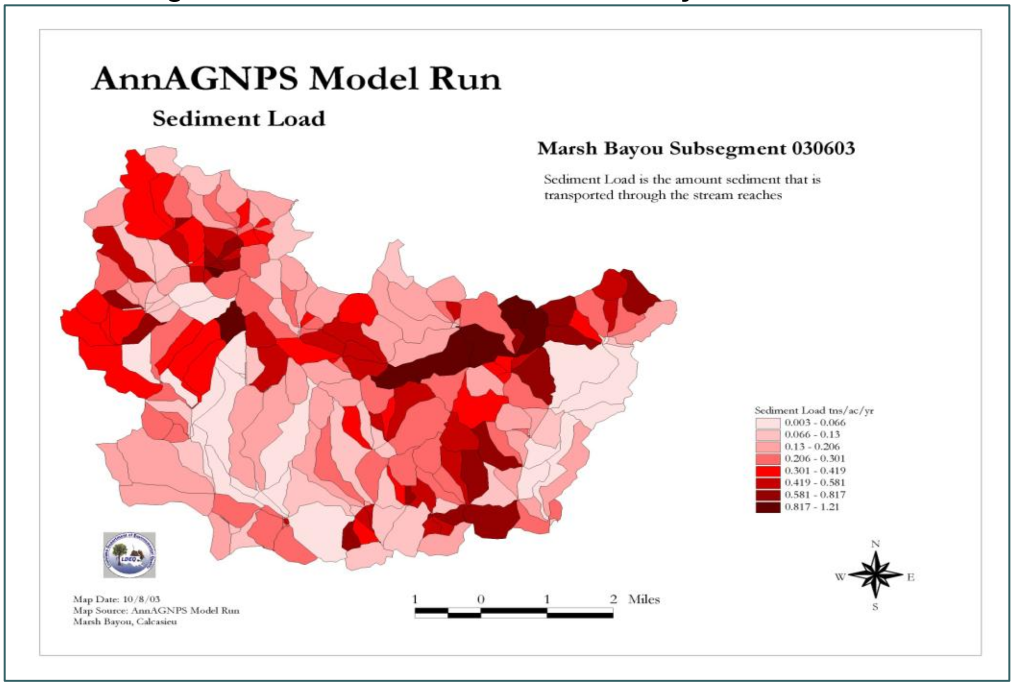
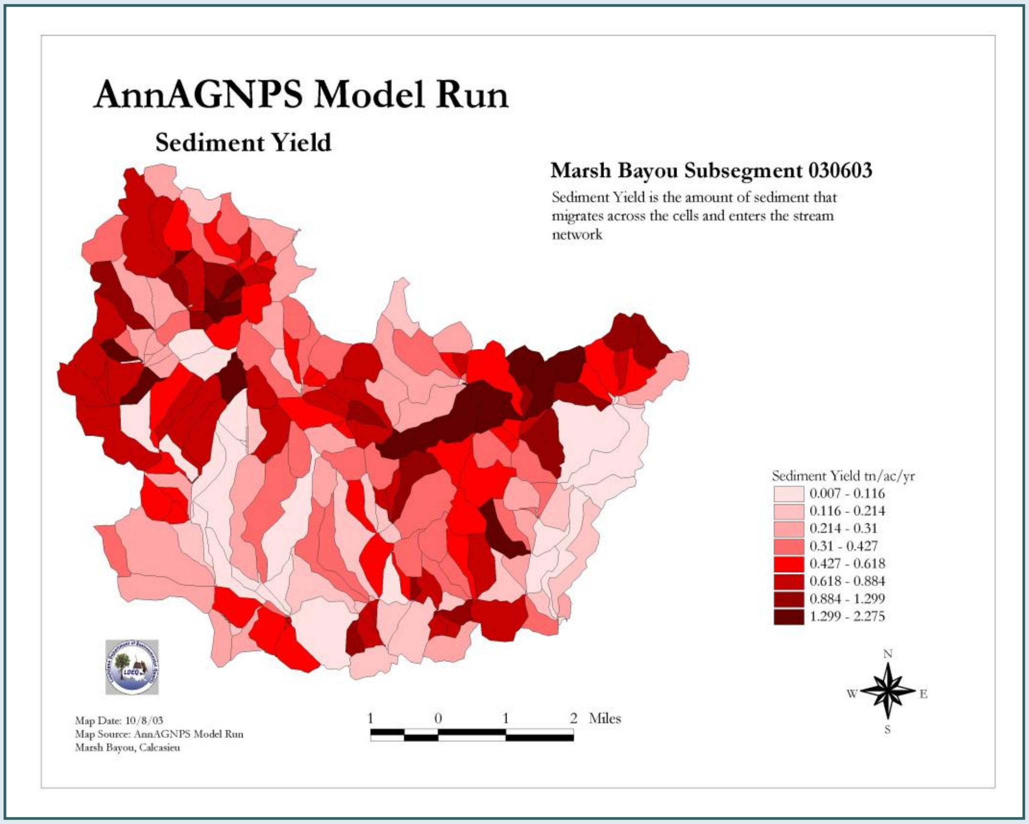


Figure 11: Sediment Load in Marsh Bayou Watershed



The two figures for sediment erosion and sediment loading indicate similar patterns with sediment moving off of the land toward the bayou. The dark red areas illustrate the parts of the watershed where the highest level of sediment originates and should be targeted for erosion control practices. There remaining figures had similar patterns for nitrogen, phosphorus and carbon, indicating that slope and soils affect the way that this watershed delivers pollutants to Marsh Bayou. Sediment yield has a similar pattern with highest sediment loading areas existing within 10-15 smaller sub-watershed areas.

Figure 12: Sediment Yield in Marsh Bayou Watershed

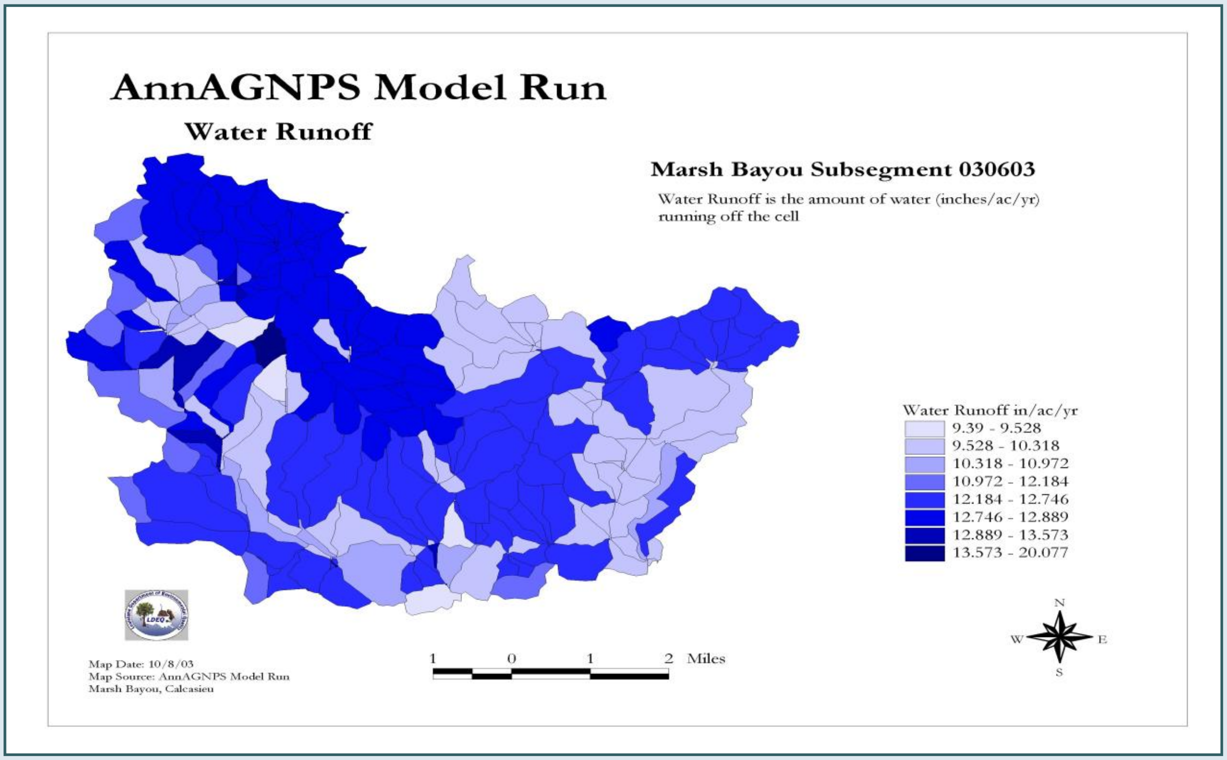


4.5 Water Run-Off

The average annual rainfall in the Marsh Bayou watershed is ~62 inches a year. Water runoff is influenced by a number of factors including soil chemical and physical properties, presence of impermeable surfaces, slope of the land, climate, type and amount of vegetative cover, and root mass. Based on many of these factors, AnnAGNPS estimates the average annual amount of water (in/ac/yr) running off from the cells.

Water is cycled through the environment following various pathways. When water precipitates from the atmosphere toward the earth's surface in the form of rain, sleet, or snow, it can become intercepted by trees and other vegetation. Remaining water can infiltrate into the ground (interflow) or wash across the surface (overland flow) to streams. Although the cycle is repeated throughout time, it can vary from one area to another and become altered by changes in land use activities. Knowing which areas in the watershed may produce greater amounts of surface water runoff, based on the type of land use activity or other factors can help focus conservation efforts that can reduce NPS pollutant loading. The model estimates that some cells are experiencing runoff amounts in excess of 20 in/ac/yr (Figure 13). The AnnAGNPS model indicates that higher amounts of water runoff occur in the higher elevations of the watershed with lower amounts occurring near the main channel of Marsh Bayou in the southern region. These areas of land could be affecting some of the stream reaches. Areas of land that characteristically yield greater amounts and higher rates of water runoff can be of concern. They can be a chronic source of pollutants, such as excessive sediment, nutrients, and organic debris. In addition, higher runoff rates and amounts can impact lower reaches and cause them to become unstable. In these cases, the downstream reaches may be experiencing bank erosion, stream aggradation, and higher SOD levels (sediment oxygen demand).

Figure 13: Water Runoff from Marsh Bayou Watershed



Further analysis of the Marsh Bayou Watershed using the AnnAGNPS model was conducted to estimate which areas have a higher potential for yielding water runoff and NPS pollutant loads. Nutrients including nitrogen, phosphorus and organic carbon are the most common of these type substances that can consume in-stream dissolved oxygen. The model results are illustrated in a graded color format shown in Figures 14 – 16. The darker colors indicate the areas that would yield water runoff containing higher amounts of nutrients. These Figures are found in the following three pages.

Figure 14: Nitrogen Loading in Marsh Bayou Watershed

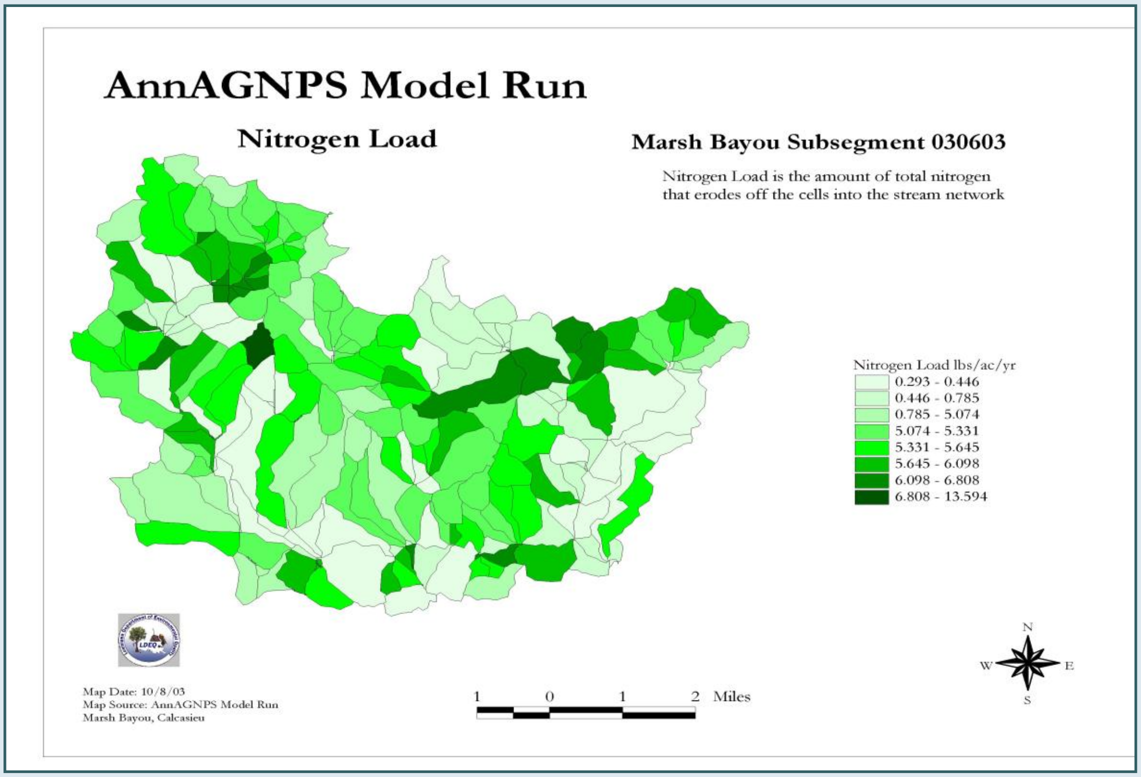


Figure 15: Phosphorus Loading in Marsh Bayou Watershed

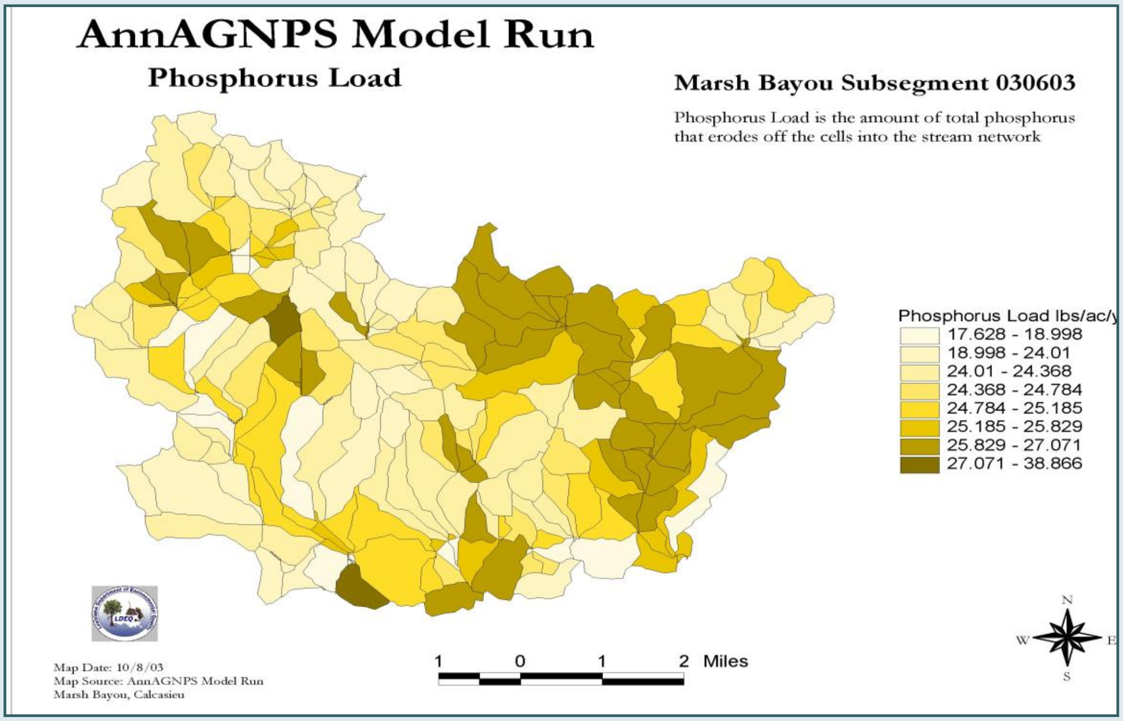
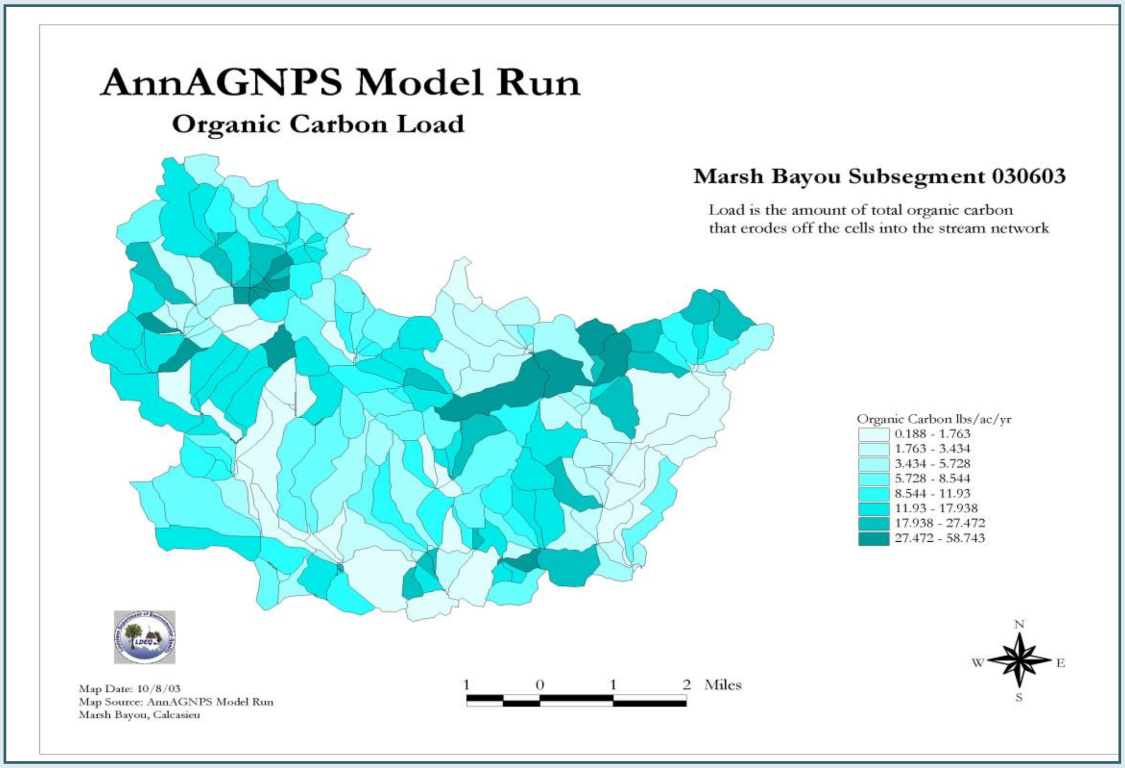


Figure 16: Organic Carbon Loading in Marsh Bayou Watershed



4.6 Summary of AnnAGNPS Results

The AnnAGNPS model estimated the land areas located in the headwater regions of both Marsh Bayou and Little Marsh Bayou are the areas in the watershed that are likely to yield more NPS loading. Based on the model results, it appears there is a ridge extending across the watershed from east to west just below its northern watershed boundary. This area is shown to exhibit a higher potential for soil erosion. The model results show that sediment erosion in these areas can be as high as 1.032 tons per acre per year, and nearly half of that amount becomes deposited into reaches 1 – 9. The AnnAGNPS model estimated a similar pattern when evaluating nitrogen, phosphorus, and organic carbon loading. The areas of land just below the northern watershed boundary exhibit higher potential for nutrient loading. An explanation to these results could be because these areas in the watershed have greater elevations and sandy soils, which can have a greater potential for erosion and water runoff. The following Table 4 provides a summary of the AnnAGNPS results for Marsh Bayou Watershed.

Table 4: AnnAGNPS Summary Table

Type of Model Results	Results	Units	Description
Sediment Erosion	1.032	tns/ac/yr	Overland erosion
Sediment Yield	0.489	tns/ac/yr	Sediment deposited in streams
Sediment Load	0.2770	tns/ac/yr	Sediment that moves through stream reaches
Nitrogen Load	3.885	tns/ac/yr	Nitrogen moving through reaches
Phosphorus Load	24.562	tns/ac/yr	Phosphorus moving through reaches
Organic Carbon Load	9.786	tns/ac/yr	Organic carbon moving through reaches

5.0 SOURCES OF NONPOINT SOURCE POLLUTION

Nonpoint source water pollution often results from many different sources in the watershed. NPS pollution can cause both direct and indirect impacts to water quality that can be both acute and/or long lasting. In the Marsh Bayou Watershed, NPS sediment and nutrient runoff have caused low dissolved oxygen levels impairing water quality. NPS sediment and nutrient runoff comes from a variety of land use activities. Therefore in order to prevent NPS loading in the watershed, all the current land uses in the watershed must be identified. Historical land uses can provide insight about historical NPS loading, which can also impair water quality. Anticipating what land use activities are likely to occur in the future can provide insight of how to avoid additional NPS loading and maintain water quality. In the Marsh Bayou Watershed, Subsegment 030603 the following land use activities were observed:

- Forestry
- Agriculture
- Land clearing/road building/bridge building
- Oil and gas production sites

Other tools that help identify potential sources of NPS loading are soil maps, topography maps, and elevation maps. Often watersheds have different types of soils that are distributed throughout the watershed. Some are more erodible and some are less fertile. The topography in the watershed can vary from areas with steeper slopes to areas of flatter regions. Watershed hydrology and drainage patterns can occur in close proximity to land use activities, which are known to produce NPS loading. Using these tools is helpful when making evaluations of how to best manage current sources of nonpoint pollution, prevent future sources, and restore historical NPS loading.

5.1 FORESTRY

Mixed Long-Leaf Pine Forest makes up the majority of forested lands in the watershed followed by Bottomland Hardwood. The 2003 detailed land-use classification indicated that there was 9,555 acres of forests or 38.38% of the watershed. Long-Leaf Pine grows in sandy soil over hardpan clay, which is present throughout the watershed. These areas occur mostly in the higher elevations of the watershed extending up to the riparian areas along the tributaries and bayou. Because of the high sand content, these soils tend to be highly erosive. Bottomland Hardwoods with mixed Cypress Tupelo are present in the lower elevations making up a natural riparian buffer area. A healthy riparian buffer is present along many of the tributaries and Marsh Bayou in varied widths. Historically, the entire watershed was forested. Today, the greatest density of mixed pine forest remaining in the Marsh Bayou Watershed is located in the northeastern portion, near the headwaters of Little Marsh Bayou. Most of the logging sites have been converted into grazing lands and/or agriculture fields, as very few harvest sites are replanted with trees. Much of the bottomland hardwoods along the waterways remain, particularly in the southeastern portion of the watershed.

Image 8: Soil Erosion Occurring in a Forested Area

Current forestry practices in the Marsh Bayou Watershed may result in nonpoint loading into the bayou. The primary nonpoint pollutant is sediment from increased erosion. Other potential pollutants include pesticides, herbicides, fertilizers, fire-retardant chemicals, organic matter and woody debris in the watercourses. Clear-cutting of trees and removal of riparian areas can cause significant nonpoint loading. Harvesting trees along watercourses also causes thermal pollution from lack of shading and increased water temperatures. Increased temperature reduces in-stream dissolved oxygen (DO). Without proper controls, local streams and waterways become impacted and water quality impaired.

Access roads, stream crossings, skid trails, shearing and windrowing are the type of forestry activities, which can generate the greatest nonpoint loading into local receiving streams. Excess sediment from erosion causes most of the nonpoint load. These activities disturb soils, exposing them to wind and rain. When rains occur over exposed or disturbed soils, the impact from falling raindrops causes soil sediment particles to become dislodged. As a result, there is sediment deposition in the lower elevations of the watershed such as local wetlands, tributaries, and the bayou. In some cases where fertilizers are used on forested lands, nutrient-rich surface runoff can occur, which consume in-stream dissolved oxygen. The most common nutrients are nitrogen and phosphorus. High in-stream nutrient concentrations can result in algae blooms and eutrophic waters (low oxygen levels in the water).

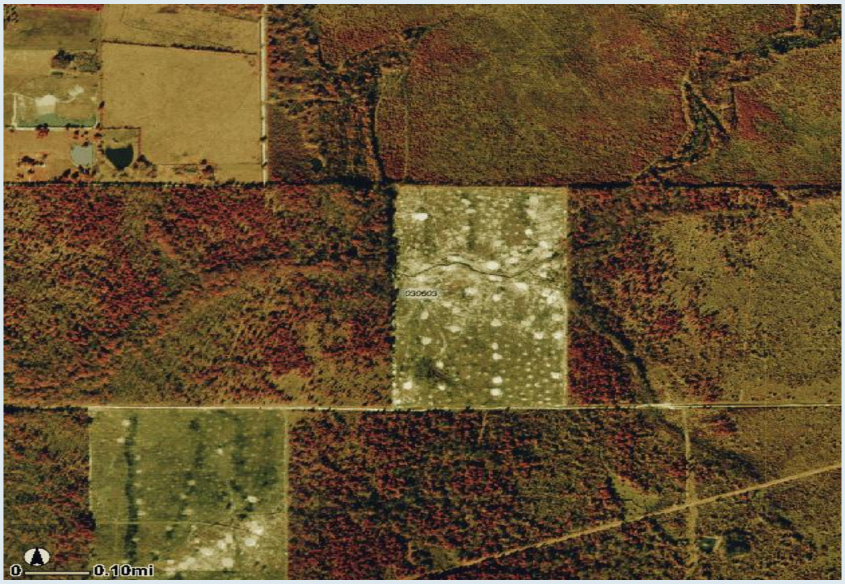


Image 9: Clear-cut forest site with trees removed from stream banks

Another significant impact to local streams caused by forestry activities can be "hydrologic alterations" to the watershed. Forested watersheds have very little erosion. Forested watersheds have less runoff rates to local streams since there is greater infiltration, percolation, and dissipation of rainfall. When forested lands are harvested, the native landscape becomes converted into an open land having less percolation and infiltration of rainfall. As a result, there are increased amounts of runoff and higher flow rates entering local receiving streams. Higher runoff velocities generate greater hydraulic energy, which destabilizes stream banks. Rushing waters cause "scouring" of stream banks. Accelerated bank erosion and bank scour produces nonpoint sediment loading to the stream. Common attributes of streams located within and downstream of clear-cut forests are live fallen trees into the channel, scoured stream banks, and washouts. In-stream sediment deposition, or "aggradation" and heavy deposits of timber slash are another stream attribute of the areas. Unfortunately, these attributes are long lasting until the stream becomes stabilized again. Excess NPS loading and unstable streams are not conducive to maintaining optimum levels of dissolved oxygen in the bayou.

5.2 AGRICULTURE

State water quality assessments continue to show that agriculture is the leading source of nonpoint source pollution to rivers and lakes (EPA 2000a). The primary agricultural NPS pollutants of concern are nutrients, sediment, animal wastes, salts, and pesticides. In the Marsh Bayou Watershed, agriculture occupies the greatest percentage of land. The primary types of agriculture are soybean, rice, pastureland grazing, and rangelands. Each type can cause NPS loading, with similar pollutants and problems of concern. The distribution of several types of agriculture production, in acres within the Marsh Bayou Watershed, is presented in Table 5.

PARISH	AGRICULTURE LAND USE/CROP	AMOUNT IN ACRES
Allen Parish	Hay Rice Soybeans	900.0 12,700.0 3,100.0
Beauregard Parish	Hay	5000.0
Jefferson Davis Parish	Hay Rice	16,000.0 81,782.0

Table 5: Amount of Agriculture Land Use (Acres) for each Parish within the Water body Subsegment 030603 (LSU Ag Center, 2008/ Louisiana Summary Agriculture and Natural Resources)

5.2.1 SOYBEANS

Soybeans are grown within the Marsh Bayou Watershed. The land-use classification from 2003 indicated that there was only 204 acres of soybeans in the watershed, but the field survey of 2009 indicated that this acreage had increased. Although more production is moving towards the Southwest U.S., farmers continue to grow soybeans because they are adaptive to different soils, climatic conditions, and there are no acreage limits for the amount of soybeans one can grow. Soybeans can also be used as a “rotation crop” because they can help maintain the soil productivity by increasing nitrogen levels. Growers can use the same equipment they use in other farm operations.

Exposed soils in tilled fields, barren drainage ditches, barren “turn-rows”, excessive fertilizers, and chemical spills are the primary sources of NPS pollution resulting from soybean production. Sediment, nutrients, and herbicide/pesticides are the primary types of NPS pollutants. Herbicides have become the most common form of weed control during the growing season; herbicides are applied up to three times. Barren fields, stream banks, canals, and/or ditches are common attributes of agriculture. However, these types of conditions are highly conducive to erosion. More so, using herbicides in close proximity to waterways has negative impacts to water quality.

Tillage, in the form of plowing of the soils, is the most common practice used to prepare the fields. Tillage starts early in the year and can occur as many as four times during a growing season. A “pre-tillage” is often used in conjunction with herbicides as another method of weed control. Unfortunately, the rainy season in Louisiana begins at this time. Freshly tilled fields without vegetative cover are extremely vulnerable to sediment loss from erosion. When rains occur, there is a significant amount of topsoil in the form of sediment that is washed into local drainages. Sediment-laden runoff contributes to the nonpoint source load, which impairs water quality. Often fields are tilled all the way to the local drainages and/or through the “turn rows” in an effort to increase growing space. As a result, there is no filtration of runoff from the soybean fields as floodwaters drain into local receiving streams. During a rain event, surface water runoff washes soil sediment and herbicide residue from these fields into local drainages. High flow rates can carry suspended sediment far from their source causing water quality problems downstream. Accumulation of sediment in the stream bottoms can exert a “sediment oxygen demand” or SOD and is the largest problem with the dissolved oxygen problem in the bayou. Most of the nonpoint load caused from soybean production results from barren soils. Since many of the soils in the Marsh Bayou Watershed have a “K-factor” (soil erodibility factor) greater than 0.4, there is an even greater chance of erosion. Additional nonpoint loading results from the nutrients present in fertilizers that are used in the fields to increase soil productivity.

Most of the soils in the watershed have low fertility, and therefore require higher inputs of fertilizers. Excessive use, untimely applications, and application near the waterways (drainages, canals, and rivers) can cause nonpoint loading. Even greater nonpoint loading can occur when the fields are barren at this time. When excessive nutrients and sediment enter the stream, they consume oxygen and cause algal blooms, which can impair water quality.

In summary, barren fields, barren drainages, lack of a vegetated perimeter, and excess herbicide and fertilizers use are primary processes involved in the soybean production, which can cause nonpoint loading to local streams in the watershed.

5.2.2 RICE

Rice production occurs in the Marsh Bayou Watershed often on a rotational basis with soybeans. The 2003 land-use classification indicated that there was 536 acres of aquaculture or rice grown in the watershed, but current acreage may be higher. Many of the same fields used for growing rice are also used to grow soybeans. Very few fields in the watershed are designated exclusively for rice production. Recently, a trend has moved toward utilizing rice fields for pastureland grazing. Traditional methods used for rice production have been known to cause nonpoint loading. The primary pollutants present in the NPS loads that result from rice operations are high amounts of suspended sediment, nutrients, and pesticides/herbicides.

The perimeters of rice fields are leeved in order for the fields to be flooded with water. Flooding rice is a common practice that helps promote seed germination. After fields are flooded, other processes such as “water leveling” and “mudding-in” take place. The mudding-in process is a common technique that is used as an effort to control the germination of red rice and level the water in the field. Red rice “wild strand” competes with the commercial rice. The mudding-in process utilizes large tractors to till and mechanically disturb the soils as necessary as they are flooded. This disturbs the waters in the rice fields as much as possible, creating extremely muddy waters. The rice seedlings are sometimes planted in the fields by airplanes. NPS loading occurs when muddy water is discharged from the rice fields. Fine particles of clay and silt become suspended during the mudding-in process and often take weeks before they can settle. Most often rice producers follow the same schedule. This causes high volumes of sediment-laden waters to be discharged into the watershed at the same time resulting in significant nonpoint loading.

Most often, elaborate drainage systems have become an integral part when maintaining rice fields. The drainages are maintained for conveying floodwaters as efficient as possible. Herbicides are often used to control weeds and vegetation growing there, leaving stream banks and in-stream channels barren. As a result there is no filtration of sediment and nutrients from the discharges and greater bank erosion. When discharges from rice fields laden with sediment and nutrients enter local receiving streams, it causes NPS loading.

5.2.3 PASTURELAND GRAZING

Pastureland grazing is common throughout the watershed, with the 2003 land-use classification indicating more than 13,466 acres of 54.10% of the watershed was in pastures. Much of the forested lands have been harvested for timber and converted into grazing lands, or pastures. Pastures require large inputs of fertilizers in order to keep a healthy food supply for the grazing animals (cattle). Excessive fertilizer, untimely applications, and application near the waterways (drainages, canals, and rivers) increase the probability of these nutrients getting washed into the river. When cattle are allowed continuous access and the grazing of the stream banks, it increases the rate of bank erosion and deposition of fecal material near the stream. Cattle are attracted to these areas because of shade, water supply, and lush vegetation. Areas having high numbers of cattle that are located near a tributary or drainage are likely to contribute a significant NPS load that can affect both the DO and fecal coliform in the river.

5.3 NEW CONSTRUCTION: (LAND CLEARING, ROAD BUILDING, AND BRIDGE BUILDING)

New developments and construction areas such as residences, road building, and bridge construction sites maintain or conserve little green space or the native landscape. When soils are exposed, they become more susceptible to erosion. When rains occur, the exposed soils result in sediment runoff. Barren soils also increase storm water runoff rates and amounts. When rains occur, there is little protection from being washed into the receiving stream. Many of the new developments in the watershed occur in critical and sensitive areas. Developing in critical and sensitive areas such as wetlands and riparian corridors reduces the capacity of the watershed to manage the pollutants within it. These areas function naturally to buffer and manage the effects of pollutants in the watershed. There is little awareness of the importance of these areas and how they function. Construction sites greater than 1 acre are regulated by NPDES Phase II Storm water Permits, which require utilization of BMPs for managing storm water runoff. Sites "less than 1 acre" are not covered by NPDES Phase II, therefore storm water management and erosion control will require voluntary implementation of BMPs. Without voluntary use of BMPs, new construction sites and developments less than 1 acre can result in NPS loading.

Image 10: Construction of a New Bridge over Little Marsh Bayou

Although residential and urban development is not currently the leading land use in the watershed, construction activities occur throughout. The Marsh Bayou Watershed is located in close proximity to the City of Lake Charles and between two major travel corridors Interstate 10 and Highway 190. Land clearing, road building, and bridge building are the most common construction activities. NPS loading is produced when these types of activities disturb soils, stream banks, and stream channels.

5.4 TRASH, LITTER, AND DEBRIS

Throughout the Marsh Bayou Watershed there are residents who dispose of their trash, litter, and debris at bridge crossings. Typically the local "parish" provides a trash pick-up service. However, the area in this watershed encompasses land included in four different parishes. Trash collection services may not be offered in one or all of the parishes, or due to finances, residents do not utilize the service. Each time it rains, the trash gets washed into the waterway, becoming "waterborne debris", which accumulates downstream and along the entire river. The NPS loading resulting from this type of waterborne debris contains oxygen consuming substances such as chemicals, oil and grease, excess organic debris, and other substances. A visual survey during May 2003 and November 2009 revealed large volumes of domestic trash at each bridge crossing. The effects of improperly disposed trash, litter and debris are apparent downstream from the headwaters. Besides degrading the aesthetical value of the tributaries and Marsh Bayou, excess amounts of trash, litter, and debris can result in both direct and indirect nonpoint source loading.

5.5 PHYSICAL, CHEMICAL, AND BIOLOGICAL PROCESSES THAT CAUSE MORE WATER QUALITY DEGRADATION

Nutrients, organics, sediment, and microorganisms are constituents that cycle within the environment. The cycling of these constituents helps to "renew" the natural resources, which are necessary for a sustainable future. The physical and chemical properties regulate how the elements are cycled in the environment. When any of the variables such as flow, temperature and pH, are changed, the natural cycle is affected. Sometimes these changes can have detrimental effects to water quality. Excess NPS pollution can deplete dissolved oxygen levels in the waterway and disrupt the natural cycle of elements, which may prolong water quality impairments.

5.5.1 SEDIMENT OXYGEN DEMAND (SOD) AND RE-AERATION

The slope of Marsh Bayou in the southern area of the watershed is very gradual as it makes its way from west to east, through a long stretch of bottomland hardwoods and cypress swamps. Surface runoff containing high amounts of sediment tends to settle-out more sediment in these slower flowing reaches of the watershed. The watershed rests on an alluvial plain where soils are composed of silty loams and clays (see soils table). Nutrients, pesticides/herbicides, and organic matter can become attached to the soils particles (sediment), which settle on the streambed and create an oxygen demand as the particles decompose. After time, this process results in a layer of muck along the streambed. This layer of muck creates what is commonly referred to as sediment oxygen demand (SOD). Agriculture has been identified as a primary contributor to the accumulation of sediment and nutrients to the waterway.

6.0 NONPOINT SOURCE BEST MANAGEMENT PRACTICES (BMPs) :Key Element 3

Implementation of land-use best management practices in the watershed constitutes the building blocks of watershed protection and improving water quality. Because rivers and streams encompass a broad range of land uses, the description of BMPs for the Marsh Bayou Watershed is divided into categories such as agriculture, forestry, and construction. Each different category contains “site-specific” BMPs that minimize a particular source of NPS pollution. BMPs can include structural controls and/or nonstructural controls. Structural BMPs or controls are those, whether natural or man-made that filters, detains, or reroutes contaminants carried in surface runoff. Nonstructural BMPs utilize techniques such as land-use planning, land-use regulations, and land ownership to eliminate or minimize sources generating a NPS loading. One of the most important pieces of successfully implementing BMPs and/or making changes in the watershed that will result in reduced NPS loads into the river is public awareness, education, and participation. Reduction and prevention of NPS pollution in the watershed will involve a concerted effort from all the stakeholders in it.

6.1 FORESTRY BMPs (Key element 2)

Forestry BMPs are designed primarily to reduce the amount of sediment runoff from forestry operation sites to local bodies of water. The primary types of forest in the Marsh Bayou Watershed are “Mixed Pine” Forest (Long-leaf, Slash, and Loblolly Pine), “Bottom Land Hardwood” Forest, and “Cypress Tupelo Swamps”. As noted in the Section 1.3 Watershed Description, the Marsh Bayou Watershed is intersected by two distinct eco-regions. The northeast portion of the watershed contained plant species present from both eco-regions in one place area. Recently, there has been more understanding about the importance that these areas play in protecting and maintaining the local environment. The areas of the watershed where these type forests are located provide “critical” and “sensitive” benefits to the overall environment. The remnants of Long-leafed Pine Forests such as in the Marsh Bayou Watershed occur in very limited areas in the State of Louisiana. They prevent the sandy soils that they occur in from washing away and are resistant to natural fires. Another attribute of these areas is they serve as a “biodiversity bank” for many of the different species native to this area of the State. In order to minimize the impacts of potential NPS pollutant loads into bodies of water in the Marsh Bayou Watershed and to sustain future timber harvests, operators should use planning tools and employ best management practices. By taking these measures, the important functions a forest provides to the watershed will be maintained while also sustaining future timber harvests.

Image 11: Forestry Site receives Award for Conservation

BMPs that minimize soil erosion and protect water quality should be used at each site. When a forested site is intended to be harvested, proper “planning” can prevent and/or minimize potential nonpoint loading. Tools that can be very helpful during the planning process are: maps identifying slopes, aerial photos, soil maps and topographical maps.

The areas of land located along a body of water or stream bank is referred to as the “riparian buffer zone”, the transitional area between land and water. A riparian zone consists of land adjacent to and including a stream, river, and or other area that is at least periodically influenced by flooding in a natural state. Similar to vegetated filter strips, plants (“native”) in the riparian area effectively prevent sediment, chemicals, and organic matter from entering bodies of water. Restricting timber harvest from these areas is a BMP that forestry operations can implement, which can significantly control NPS loads from the site and protect water quality. Unlike filter strips, riparian zones are composed of higher order plants, such as trees and shrubs, as well as grasses, legumes, and wetland plants. Vegetated filter strips can be used in conjunction with riparian areas as an initial filtering component for sediment runoff from a timber site. Vegetated Filters and Riparian buffers can reduce the sediment and nutrient loads entering the water body by 40-50%.

Practices that can be implemented to reduce both direct and indirect NPS loads are “select cut techniques” and “no tree felling within wet areas”. On sites that are subject to clear-cut treatments, assistance from forestry professionals should be provided. If the clear-cutting practice is utilized, then special protection should be given to maintaining the healthy riparian buffer along local watercourses. This is a best management practice (BMP) that can function to prevent excess NPS loading from clear-cut sites. It is realized that the clear-cutting practice is often employed to establish “even-aged” crops when replanting is intended. The widths of riparian buffers or streamside management zones (SMZs) often vary, but should be wide enough to function. When timber harvest occurs near riparian areas, the disturbed site should be seeded as soon as possible with a “native grass” in order to stabilize the soil and filter surface runoff. Maintaining a grassed area on the down-slope of site can effectively slow down surface runoff and filter sediment. It is important to use only native grasses for this purpose as exotics can invade and destabilize the ecology of the area.

All trash at the harvest site should be removed. This includes oil cans, grease rags, etc. Minimize the amount of debris by maximizing the use of all trees cut in the woods and on the landing. Cut stumps low to the ground. Lop slash to within two feet of the ground. Try to minimize damage to trees that aren't harvested. Other general forestry practices are:

<u>Roads:</u> The Marsh Bayou Watershed has erosive soils with sloping topography. In these hilly areas, appropriate water bars, rolling dips or broad base dips should be used to prevent erosion on temporary and permanent roadways. Forest roads can deliver high sediment loads if these types of BMPs are not utilized. When harvesting is completed, temporary roads should be closed and planted with appropriate vegetation.

<u>Harvesting:</u> During harvesting, trees should be felled away from water bodies whenever possible. Insure there is not an excessive amount of fallen treetops remaining in streams or drainage areas. Inspect streams to insure it is not clogged with logging debris. When skidding, appropriate maps should be utilized to insure the best path for skid trails is taken. Keep stream crossings to a minimum, but when the stream must be crossed, the logger should cross the stream at right angles in a straight section of the stream. Skidder loads should be light in sensitive areas to prevent soil disturbance. After skidding is completed, all stream crossing structures should be removed and trails planted with the appropriate vegetation

<u>Site Prep:</u> During site prep, boundaries for all SMZs should be established. Ripping shearing, windrowing and mechanical planting should follow the contours of the land. Hand plant the highly erodible areas. Leave debris on the site on highly erodible areas. Limit any activity within SMZs and never cross-streams during site prep.

<u>Pesticide and Herbicide Application:</u> Follow Federal and State laws regarding chemical application. Apply chemicals only at rates specified by the chemical manufacturer. Consider soil types, topography, hydrology and weather when applying chemicals. Chemical mixing should be done at the application site only and where chemicals could not enter streams.

<u>Forested Wetlands:</u> Never harvest during wet periods. Use low air pressure in tires. Keep skidder loads light, fell trees away from water body and remove debris from the water bodies, and do not cut trees in standing water.

Utilizing select cut techniques helps maintain sustainable forestry operation without impairing its functions in the local environment. For the foresters who employ "select cut techniques" and avoid cutting timber from wet areas and riparian zones, incentives should be provided since their actions will benefit the entire watershed. The incentives could be in the form of finance (tax exemptions) and recognition as a Steward of the environment and industry. Foresters who maintain sustainable Long-leaf Pine populations should also have these incentives.

Effective implementation of BMPs will require programs that provide technical information, facts, and incentives for helping foresters. These programs should be designed to create awareness and participation in BMP implementation. LDEQ continues to work cooperatively with all the local and state forest entities to provide statewide forestry educational programs. BMP training workshops should be hosted throughout the Vermilion River Watershed. An example of such a program is the "Master Logger Program" established by the LDAF and the Forestry Industry. A comprehensive list of forestry BMPs with explanation and illustrations of forestry practices is found in *Louisiana's Forestry BMP Manual.* A list of program activities for forestry is included in *Louisiana's Nonpoint Source Management Plan, 2000*.

6.2 AGRICULTURE BMPs

Agricultural BMPs are generally associated with the management of soil, nutrients, pesticides, and water, which are known to be a contributing source of NPS pollutant loading. If sediment, fertilizers, and herbicides/pesticides remained in the fields, the NPS load would be less. Runoff is a natural occurrence and agricultural sites are no exception. Therefore, sites should be managed in such a way that the surface runoff rate is not excessive and that it is not contaminated. Reducing NPS loading resulting from agriculture will require a concerted effort between all the associated federal, state, and local agencies. Proper management will require agriculture programs, which provide environmental education as well as effective production strategies. Agriculture programs should be designed to foster a sense of conservation stewardship for each type of agricultural producer. Examples of these programs are the "Louisiana Master Logger Program" for affiliates in forestry, and, the "Louisiana Master Farmer Program".

A general type of BMP that can be very cost effective for all types of agriculture production is to utilize the drainage ditches for each site to serve as a passive form of biological treatment for the runoff draining from the fields. The "open drainage ditches" at each site could be enhanced with "native" grasses and/or wetland plants. This type of practice often occurs naturally throughout the State of Louisiana, serving as a form of filtration for surface runoff waters. Most agricultural field sites, whether pastureland, row crops, forestry, nursery, and/or rice and crawfish already maintain an "open ditch system", designed to remove surface runoff and prevent flooding. This practice is similar to the BMP referred to as a "grassed waterway", but focuses on use of "native" vegetation and wetland plants, where possible. It is widely known that the roots of wetland plants provide an oxygen rich environment where there are high densities of microbes, which biologically degrade nutrients and pollutants into harmless substances. Other benefits of utilizing this BMP include:

1) <u>Minimize soil loss</u> resulting from barren fields and eroding ditch banks;
2) Ditch serves as a "capture mechanism" for soil loss from the field, which can be recovered and redistributed by the farmer as necessary;

3) Wetland plants impede less flow than weeds due to their nature to lay down with the water flow. A significant flow also occurs under the surface of the ditch bed through the plant roots, which are highly permeable;
4) Reduced herbicide use because the native vegetation, once established, will out-compete and eliminate future weed growth;
5) Benefits local environment (Gulf Coast Region), supports a healthy aquatic landscape and increases aesthetics.

Another consideration is to convert the "marginal land" in the field that has low productivity, such as naturally wet areas and areas near the edge of streams, back into the native landscape. Typically, excess resources and finances are wasted on these type areas only to produce a below average yield. The time, manpower, supplies, and capital that is used on the "marginal areas" could be focused on the quality management of the productive lands. When marginal areas are converted back to their natural state, they will serve a greater value to the landowner and the watershed. The land can serve as a buffer, offsetting the effects of production activities, as a hunting lease, for future timber harvest, and/or recreation.

For successful agricultural programs to continue in the watershed, all the cooperating entities will need to participate. The key partners (i.e. NRCS, SWCD, LDAF, LCES, LDNR, and FSA) are the federal, state, and local agencies, which provide funding through cost-share assistance, incentives, expertise through technical assistance, and education through information outreach programs to the farmers. A complete list of agriculture BMPs is provided by the NRCS in their "Technical Guide Handbook". The handbook includes a description of each BMP and their recommended uses. Each BMP is listed by a "code", i.e. Field Border (386). LDEQ has a comprehensive list of BMPs for controlling NPS pollutant loads, programmatic goals and activities, and future objectives and milestones included in the State of Louisiana Water Quality Management Plan, Volume 6, *Louisiana's Nonpoint Source Management,* 2000.

Image 12: Using Mowing machines as opposed to herbicides for stream bank maintenance helps keep vegetative roots in tact; in return, there is less erosion and more filtration of pollutants.

6.2.1 SOYBEAN BMPs

Traditional soybean production involves “tillage practices” that pulverize the soil in order to successfully grow a new crop. BMPs for this type of land use should be focused on soil and water management, pesticide and nutrient management. These constituents are known to cause NPS pollutant loads, if they are washed into the receiving stream by surface runoff. Controlling the NPS pollutant loading requires implementing BMPs that reduce the amount of surface runoff and the amount of NPS pollutants in it. Conservation tillage practices such as “stale seed bed” and “no till” have proven to be successful in producing 50% less NPS loads such as sediment into the water body. These practices utilize bulk organic matter remaining from winter crops as a sponge, while planting directly into it. Planting soybeans directly into the soil without tillage is another conservation practice. Conservation tillage is designed to reduce the amount of runoff and rates of flow. In return, there is more sediment, nutrients, and pesticides/herbicides remaining in the fields for growth each growing season. This saves money in costs and reduces NPS loading. Another BMP is to dedicate a strip of land around the perimeter of the field, planted with native grasses that could function as a sediment filter. As runoff washes from the fields, the strip of grass (vegetated filter strip) slows the flow rate and captures sediment. As mentioned earlier, the use of “grassed waterways” covered with native vegetation can do much in the way of capturing sediment runoff draining from field sites. The recommended approach for “maintenance” needed on grassed waterways is occasional mowing of stream banks and “select” use of herbicides for invasive weeds. Sometimes herbicides are used to rid weed invasions and allow for the establishment of native plants. These BMPs are very cost effective and prevent NPS loading. In addition to implementing BMPs, the producer should develop and utilize pollution prevention strategies such as spill prevention practices for sites where the agrochemicals and fertilizers are stored, off loaded, or prepared for field application.

For a more detailed description and list of BMPs that are recommended for controlling NPS pollution for each type of agriculture in the Marsh Bayou Watershed, refer to the *Louisiana’s Nonpoint Source Management Plan, 2000.*

6.2.2 RICE BMPs

There is a small to moderate amount of rice production within the Marsh Bayou Watershed. NPS loads resulting from rice fields occur when the rice fields are prepared for planting (mudding in) and during the time of harvest. Controlling the pollutant loads that occur during these times will prevent a significant amount of NPS loading. This will require implementing BMPs that reduce the quantity and improve the quality of the discharges from the rice fields. Examples of recommended BMPs are “precision leveling” and using dry seed beds, otherwise known as “clear-field” planting. By retaining the water for 15 days on the field prior to releasing it during the planting cycle, 50-75% of the sediments and organic material can be removed from the discharge waters.

6.2.3 PASTURELAND GRAZING BMPs

Since pastureland grazing occupies a major portion of agricultural land-use in the watershed, pastureland grazing BMPs should focus on measures to control the amount of sediment, nutrients, and fecal coliform in the surface waters draining from the field site. Work that has been done in other watersheds in south Louisiana has indicated that sediment and nutrients can be reduced from 35-65% with rotational grazing and fecal coliform can be reduced by 50%. Knowledge of the field site's delineation and drainage pattern can be helpful when identifying pathways and potential sources of NPS pollutants. During or shortly after a rainfall event is the best time to make this assessment. With this information, the operator can work strategically to implement the BMPs that prevent pollutant sources and/or prevent them from leaving the site.

Field sites having a high population density of grazing animals should consider field-rotations to allow for re-establishment of vegetation cover and maintenance. Sites with a healthy cover of vegetation have less runoff, thus less NPS loading. If a field site's size is not adequate enough space for "field-rotations", ponds could be constructed to capture excess surface runoff from the site. The surface could be routed through a vegetated field ditch, which would work in conjunction with the pond to reduce NPS loading from leaving the site. These practices help to keep the sediment, nutrients, and fecal coliform at the field site.

The Marsh Bayou Watershed has a network of drainages and tributaries that support the river. The land in and along field ditches, wetlands, and stream banks is very important for preventing sediment, nutrients, and organic matter from entering bodies of water. This area of land between wet and upland landscapes is referred as the "riparian buffer zone". Protecting these areas from continuous livestock grazing is an effective BMP for preventing NPS pollutant loading. Livestock often access these areas for a source of water, shade, and lush vegetation. When livestock are restricted from the riparian buffer zone, the producer should make accommodations to provide an alternative source of water, shade, and food. An extra step would be to locate these supplies under a covered area that provides shade for the animals.

As noted earlier, a general and cost effective practice is to maintain a strip of vegetation around the perimeter of each field site and within the field ditches. This practice is similar to the BMP referred to as "vegetative filter strip or field border" and the "grassed waterway", except use of native vegetation for cover is encouraged. If the grassed waterway is covered with wetland plants and/or native grasses, the drainage way can also function as a form of passive biological treatment, which can also reduce NPS loads. The amount of herbicides used should be less, saving costs.

6.3 CONSTRUCTION BMPs

Land clearing, road building, bridge building, "new developments and construction sites" greater than 1 acre are required by NPDES "Phase II" Storm Water Regulations to obtain a NPDES Permit before construction occurs. By providing education outreach, BMP training workshops, and inspections, these noncompliance events would likely be avoided. Personnel trained in the areas of storm water and sediment management could perform inspections. Construction site managers could be provided educational materials and information sources necessary to avoid noncompliance events with NPDES Phase II Storm Water regulations.

6.4 TRASH, LITTER AND DEBRIS BMPs

Controlling the amounts of trash, litter, and debris in the Marsh Bayou Watershed will reduce the amount of waterborne debris, resulting in a significant NPS load reduction. Rural areas of the watershed have little exposure to educational programs regarding proper waste disposal or the importance of protecting water quality. Some of these places have no options for disposing of their waste, so they do what is most convenient to them. Education of the watershed concept and stewardship practices should be provided on a “Parish Level”. These steps serve as a foundation for future stewardship, appreciation, and pride amongst the residents of Marsh Bayou Watershed. By fostering a since of appreciation and pride of the river and water resources for residents living in these areas, they will volunteer to protect it by properly disposing of their wastes. Establishing local groups and community clean-up can help to create community participation. .

7.0 MAKING THE IMPLEMENTATION PLAN WORK

To implement BMPs and/or other conservation practices in order to reduce the NPS load in the Marsh Bayou Watershed so that it meets its designated uses and is no longer listed on the 303(d) list, will require programs that provide technical assistance, funding, incentives, as well as foster a sense of stewardship. Many of these programs that are designed to assist the landowner are already in place. The LDEQ’s Nonpoint Source Unit provides monies distributed through the USEPA under Section 319 of the CWA. The funds are utilized to implement BMPs for all types of land uses within the watershed in order to reduce and/or prevent the NPS pollutants and achieve the river’s designated uses. The USDA and NRCS are federal government agencies that have several such programs made available by way of the Farm Security and Rural Investment Act of 2002. These programs are made available through the local Soil and Conservation District (SWCD). The NRCS has a list of BMPs for almost all types of agriculture and programs to facilitate their use. LDAF provides section 319 funds to assist with the costs of implementing agricultural BMPs in watersheds where TMDLS and watershed implementation plans have been developed.

Contact with the drainage district in the Calcasieu area has been made. Many beaver dams have been removed in the Calcasieu area of Marsh Bayou. Beaver dams are a big problem in the Marsh Bayou. Once the dams are removed the beavers can build them again in a short amount of time. There seems to be a continuing effort to remove as many as possible. There is a great deal of household debris in the bayou. FEMA funds have been requested to assist with debris removal in Beauregard Parish, but implementation has not yet occurred in Jeff Davis Parish. The process to approach FEMA for funding to help with the debris removal project will hopefully soon be started in Allen and Calcasieu parishes. More education and outreach projects should be done within this watershed. Hopefully funds would be available for a project that would involve the repair or replacement of septic tanks in order to reduce with the fecal contamination in the watershed. More stakeholder involvement is needed within this watershed. This way strategic planning with landowners can be accomplished in order to get various BMPs on the ground.

"Parish-wide" cooperation and coordination will be necessary in order to protect the water quality within the watershed. The Marsh Bayou Watershed is especially challenging since it encompasses four different parishes. Though challenging, it is an opportunity and reason for leaders, officials, and local citizens to come together for a common interest. As a result, people develop new relationships. The watershed approach helps build new levels of cooperation and coordination, which is necessary to successfully control NPS loading.

7.1 ACTIONS BEING IMPLEMENTED BY LDEQ

The LDEQ is designated the lead agency for implementation of the Louisiana Nonpoint Source Program. The LDEQ Nonpoint Source Unit through the USEPA utilizes funding allocated from the Clean Water Act, Section 319(h) to assist in implementation of BMPs and to address water quality problems on sub-segments listed on the 303(d) list. LDEQ has recently utilized a portion of the 319(h) grant to hire local watershed coordinators to assist the local stakeholders and partners in restoring their watersheds. Within the Calcasieu River Basin, the Imperial Calcasieu Resource Conservation and Development District (R.C& D) houses the watershed coordinator. The watershed coordinator and LDEQ's NPS staff will be working with landowners, Soil and Water Conservation Districts and local citizens on implementing the types of BMPs that will be necessary to reduce nonpoint source pollutants and restore water quality.

Members of the NPS section at LDEQ are in the process of developing a QAPP for the purpose of implementing a monitoring project in the Marsh Bayou watershed. The objectives of the project are the following: water sampling and data collection, find hot spots, figure out what BMPs are needed and where, determine where pollutant loads are occurring in the watershed, and finally, to track the effectiveness of the BMPs. The overall NPS program goal of this monitoring project is to have a success story and get the Marsh Bayou watershed delisted.

The 319 grant funds are utilized to sponsor the cost sharing, monitoring, and education projects for all types of land uses such as, urban, agriculture, hydromodification, and home sewage. These monies are available to all private, for profit, and nonprofit organizations that are legal entities or governmental jurisdictions including: cities, counties, tribal entities, federal agencies, or agencies of the State. Presently, LDEQ is cooperating with such entities on many NPS projects, which are active throughout the state. In the Calcasieu River Basin, there is the following project: "Improving Water Quality through an Integrated Watershed Approach in the Mermentau and Calcasieu Basins".

7.2 ACTIONS BEING IMPLEMENTED BY OTHER AGENCIES (Key Element 4)

The U.S. Department of Agriculture (USDA) and Natural Resource Conservation Service (NRCS) offers landowners financial, technical, and educational assistance to implement conservation practices and/or BMPs on privately owned land to reduce soil erosion, improve water quality, and enhance crop land, forest land, wetlands, grazing lands and wildlife habitat. The "Farm Security and Rural Investment Act of 2008", known as the 2008 Farm Bill provides funding to various conservation programs for each state by way of the NRCS and the State's local Soil and Water Conservation Districts (SWCD). Although most of these programs are designed to assist agriculture, there may be cases where they may be utilized for conservation practices for other land uses. A complete list of agriculture BMPs is provided by the NRCS in their "Technical Guide Handbook". The handbook includes a description of each BMP and their recommended uses. Each BMP is listed by a "code", i.e. Field Border (386). The following includes a brief summary of the programs available through the local SWCD under the oversight of USDA an NRCS. The descriptions of the program are general and are based on information available at the time; key points subject to change as rules established.

The following information was provided by the Local Soil and Water Conservation District and USDA on the type and acreage of BMPs that have already been applied within the Marsh Bayou Watershed.

Table 6: BMP's Applied in Marsh Bayou 030603
Beauregard Parish

Program	***CTA***	***EQIP***	***Totals***
BMP	***Ac/No/Ft***	***Ac/No/Ft***	***Ac/ No/ Ft***
314 - Brush Management (Ac)	0	540.2	540.2
327 - Conservation Cover (Ac)	0	31	31
329A - Residue Mgmt No Till (Ac)	70.1	714.3	784.4
342 - Critical Area Planting (Ac)	0	145.8	145.8
351 - Well Decommissioning (No)	0	1	1
378 - Pond (No)	0	4	4
382 - Fence (Ft)	0	17062	17062
393 - Filter Strip (No)	30	1.1	31.1
410 - Grade Stabilization Structures (No)	1	5	6
449 - Irrigation Water Mgmt (Ac)	35	378.8	413.8
464 - Irrigation Land Leveling (Ac)	0	555.9	555.9
490 - Tree/Shrub Site Prep (Ac)	0	31	31
511 - Forest Harvest Mgmt (Ac)	24.3	0	24.3
512 - Pasture/Hayland Planting (Ac)	0	54.5	54.5
516 - Pipeline (Ft)	40	0	40
528A - Prescribed Grazing (Ac)	423.3	796.2	1219.5
590 - Nutrient Management (Ac)	120	451.3	571.3
595 - Pest Management (Ac)	120	451.3	571.3
612 - Tree/Shrub Establishment (Ac)	0	31	31
646 - Shallow Water Mgmt for Wildlife (Ac)	237.1	781.8	1018.9

Table 7: BMPs Applied in Marsh Bayou 030603
Allen Parish

Program	***CTA***	***WHIP***	***Totals***
BMP	***Ac/Ft***	***Ac/Ft***	***Ac/Ft***
338 - Prescribed Burning (Ac)	412.8	45	457.8
394 - Firebreak (Ft)	0	8100	8100
490 - Tree/Shrub Site Prep (Ac)	0	164.8	164.8
612 - Tree/Shrub Establishment (Ac)	0	164.8	164.8
645 - Upland Wildlife Habitat (Ac)	0	407.8	407.8
666 - Forest Stand Improvement (Ac)	0	6	6

Table 8: BMPs Applied in Marsh Bayou 030603

Totals Beauregard & Allen Parishes

Program	***CTA***	***EQIP***	***WHIP***	***Totals***
BMP	***Ac/ No/ Ft***	***Ac/ No/ Ft***	***Ac/ No/ Ft***	***Ac/ No/ Ft***
314 - Brush Management (Ac)	*0*	*540.2*	*0*	***540.2***
327 - Conservation Cover (Ac)	*0*	*31*	*0*	***31***
329A - Residue Mgmt No Till (Ac)	*70.1*	*714.3*	*0*	***784.4***
338 - Prescribed Burning (Ac)	*412.8*	*0*	*45*	***457.8***
342 - Critical Area Planting (Ac)	*0*	*145.8*	*0*	***145.8***
351 - Well Decommissioning (No)	*0*	*2*	*0*	***2***
378 - Pond (No)	*0*	*4*	*0*	***4***
382 - Fence (Ft)	*0*	*17062*	*0*	***17062***
393 - Filter Strip (No)	*30*	*1.1*	*0*	***31.1***
394 - Firebreak (Ft)	*0*		*8100*	***8100***
410 - Grade Stabilization Structures (No)	*1*	*5*	*0*	***6***
449 - Irrigation Water Mgmt (Ac)	*35*	*378.8*	*0*	***413.8***
464 - Irrigation Land Leveling (Ac)	*0*	*555.9*	*0*	***555.9***
490 - Tree/Shrub Site Prep (Ac)	*0*	*31*	*164.8*	***195.8***
511 - Forest Harvest Mgmt (Ac)	*24.3*	*0*	*0*	***24.3***
512 - Pasture/Hayland Planting (Ac)	*0*	*54.5*	*0*	***54.5***
516 - Pipeline (Ft)	*40*	*0*	*0*	***40***
528A - Prescribed Grazing (Ac)	*423.3*	*796.2*	*0*	***1219.5***
590 - Nutrient Management (Ac)	*120*	*451.3*	*0*	***571.3***
595 - Pest Management (Ac)	*120*	*451.3*	*0*	***571.3***
612 - Tree/Shrub Establishment (Ac)	*0*	*31*	*164.8*	***195.8***
645 - Upland Wildlife Habitat (Ac)	*0*	*0*	*407.8*	***407.8***
646 - Shallow Water Mgmt for Wildlife (Ac)	*237.1*	*781.8*	*0*	***1018.9***
666 - Forest Stand Improvement (Ac)	*0*	*0*	*6*	***6***

Table 9: Associated Costs of BMPs Applied in Marsh Bayou 030603

Program	***CTA***	***EQIP***	***Average***	***Average***	***WHIP***	***Average***	***Average***	***Totals***
BMP	***Ac/ No/ Ft***	***Ac/ No/ Ft***	***Costs / Unit***	***Cost***	***Ac/ No/ Ft***	***Costs / Unit***	***Costs***	***Ac/ No/ Ft***
314 - Brush Management (Ac)	0	540.2	$ 35.00	$ 14,180.25	0		$ -	**14755.45**
327 - Conservation Cover (Ac)	0	31	$ -	$ -	0		$ -	**31**
329A - Residue Mgmt No Till (Ac)	70.1	714.3	$ 15.00	$ 8,035.88	0		$ -	**8835.275**
338 - Prescribed Burning (Ac)	412.8	0	$ -	$ -	45	$ 25.00	$ 843.75	**457.8**
342 - Critical Area Planting (Ac)	0	145.8	$ 150.00	$ 16,402.50	0		$ -	**16698.3**
351 - Well Decommissioning (No)	0	2	$ 17,645.00	$ 26,467.50	0		$ -	**44114.5**
378 - Pond (No)	0	4		$ -	0		$ -	**4**
382 - Fence (Ft)	0	17062	$ 1.30	$ 16,635.45	0		$ -	**33698.75**
393 - Filter Strip (No)	30	1.1	$ 143.00	$ 117.98	0		$ -	**292.075**
394 - Firebreak (Ft)	0		$ -	$ -	8100	$ 0.27	$ 1,640.25	**8100**
410 - Grade Stabilization Structures (No)	1	5	$ 1,376.00	$ 5,160.00	0		$ -	**6542**
449 - Irrigation Water Mgmt (Ac)	35	378.8	$ 6.00	$ 1,704.60	0		$ -	**2124.4**
464 - Irrigation Land Leveling (Ac)	0	555.9	$ 237.00	$ 98,811.23	0		$ -	**99604.125**
490 - Tree/Shrub Site Prep (Ac)	0	31	$ 20.00	$ 465.00	164.8	$ 12.00	$ 1,483.20	**680.8**
511 - Forest Harvest Mgmt (Ac)	24.3	0	$ -	$ -	0		$ -	**24.3**
512 - Pasture/Hayland Planting (Ac)	0	54.5	$ 32.00	$ 1,308.00	0		$ -	**1394.5**
516 - Pipeline (Ft)	40	0		$ -	0		$ -	**40**
528A - Prescribed Grazing (Ac)	423.3	796.2	$ 10.00	$ 5,971.50	0		$ -	**7201**
590 - Nutrient Management (Ac)	120	451.3	$ 5.00	$ 1,692.38	0		$ -	**2268.675**
595 - Pest Management (Ac)	120	451.3	$ 5.00	$ 1,692.38	0		$ -	**2268.675**
612 - Tree/Shrub Establishment (Ac)	0	31	$ 55.00	$ 1,278.75	164.8	$ 55.00	$ 6,798.00	**1529.55**
645 - Upland Wildlife Habitat (Ac)	0	0	$ -	$ -	407.8	$ -	$ -	**407.8**
646 - Shallow Water Mgmt for Wildlife (Ac)	237.1	781.8	$ 5.00	$ 2,931.75	0		$ -	**3955.65**
666 - Forest Stand Improvement (Ac)	0	0	$ -	$ -	6	$ 65.00	$ 292.50	**6**
				$ 202,855.13			**$ 11,057.70**	

These are estimated Cost ONLY, Based on Statewide Average Costslist for 2005		
CTA is non cost shared along with (645) Upland Wildlife Habitat, (327) Conservation Cover		
(378) Pond is calculated by Cubic Yard, not per each, therefore, a cost was unable to be Calculated.		

These tables indicate the types, acreage, and estimated costs of practices that are being implemented within the Marsh Bayou watershed. Fencing and prescribed grazing and burning are BMPs that have been utilized extensively in the watershed on pasturelands. Since there is over 13,000 acres of pasturelands within this watershed, these tables indicate that there has been more than 1274 acres of pastureland BMPs implemented. Nutrient and pesticide management are also widely utilized on 571 acres of land. There has been 17,062 feet of fencing utilized on pastures within the watershed. Tree establishment, upland wildlife habitat and shallow water management for wildlife are also popular practices within the watershed with more than 1800 acres of practices implemented. All of these BMPs will reduce the types of pollutants that contribute to bacterial and dissolved oxygen problems that exist within Marsh Bayou.

LDEQ will be working with the local watershed coordinator and the soil and water conservation districts to determine how much of this implementation has been in the high priority areas of the watershed that were identified through the AnnAGNPS watershed model. This targeted implementation of BMPs is the key to reducing the pollutant load and improving water quality in Marsh Bayou.

LDEQ will continue to monitor the bayou to see if water quality is improving as a result of BMP implementation. The criteria that will be utilized to determine whether water quality has been restored will be the water quality standards. These standards are the basis for maintaining and restoring the designated uses for the bayou.

8.0 DESIGNATED USES OF MARSH BAYOU AND ITS WATER QUALITY STANDARDS (Key Element 7)

Water quality standards are developed by LDEQ in order to support the "designated uses" for each water body in the State. Both general and numeric criteria are used to support each designated use. The Marsh Bayou Watershed, sub-segment 030603 has the following designated uses: primary contact recreation, secondary contact recreation, and fish and wildlife propagation. The numerical water quality criterion that supports the designated uses of Marsh Bayou is shown in Table 2.

Table 9: Numerical Criteria for Marsh Bayou (LDEQ, 2000).

Water Quality Parameters	Numerical Criteria
Chlorides (mg/L)	60
Sulfates (mg/L)	60
PH	6.0 – 8.5
Bacteria Concentration (MPN/100mL)	200 (summer value) and 1,000 (winter value)
Temperature C •	32
Total Dissolved Solids (mg/L)	250
Dissolved Oxygen (mg/L)	5.0

These criteria will be what LDEQ will utilize to determine if water quality is improving as a result of BMP implementation. If the water quality monitoring indicates that seasonal and annual trends are improving and water quality standards are being met, then the water body can be removed from the 303(d) list. LDEQ would also write a success story about the project and submit it to EPA for posting on the national NPS website.

9.0 TIMELINE FOR THE NPS IMPLEMENTATION PLAN (key element 6)

The NPS Implementation Plan for the Marsh Bayou Watershed will be submitted to EPA during the year of 2010. This document outlines a 5-year management plan to reduce NPS pollutants from entering the waterway. LDEQ intensively samples each watershed in the state once every 4 years to see if the water bodies are meeting water quality standards. The first cycle of sampling began in 1999 in the Calcasieu River Basin, which included the Marsh Bayou and occurred again in 2005. LDEQ collected data again in 2008/2009 and will collect again in 2012/13.

10.0 SUMMARY

In order to restore the water quality and designated uses of “Fish and Wildlife Propagation” in Sub-segment 030603 in the Marsh Bayou Watershed, it will require a concerted effort from all of the stakeholders within it, including government (local, state, and federal), private and public groups and local citizens. Everyone lives there and/or owns property in the watershed is a “stakeholder” and stands to benefit from their contribution toward protecting it. Public education is the first critical element for accomplishing goals and objectives, because it is necessary that they understand and support efforts to implement BMPs. Successful outcomes are more likely, when citizens understand what is occurring and why. When stakeholders volunteer to demonstrate conservation practices on their land, they should receive positive recognition and other incentives. Soon, there will be even greater participation.

The dominant land use in the watershed is agriculture followed closely by forestry, road construction/bridge building/construction, rural residential and natural areas. Each type of land use that is identified within sub-segment 030603 have BMPs that are known for reducing NPS pollutants loads. Prevention of sediment runoff and runoff containing excess nutrients from land use activities occurs within the Marsh Bayou Watershed and will make significant water quality improvements in Marsh Bayou. Improved water quality will help to achieve and to sustain the bayou’s designated uses, which in turn benefits other natural resources and future generations to come. For the lands in the watershed used for forestry production, sediment and erosion control practices should be implemented and always practiced. Planning is likely the greatest strategy for controlling NPS loading from forestry sites. Use of maps for identifying near by streams, land topography, and drainage patterns can effectively increase a forester’s strategy when developing a plan for preventing NPS loading by implementing BMPs. Preservation of the riparian areas along tributaries is another BMP that can function to prevent NPS loading from forestry activities as well as other agricultural activities and land use types. Any type of land use activity that disturbs the soil and/or leaves an area of barren earth for a period of time should plan to utilize existing plants as filters or establish new vegetation around the perimeter of the disturbed site. Additionally, vegetation could be established on the down slope of the site. These type BMPs are very simple and very cost-effective, although there may be others types, which may or may not be more effective at preventing NPS loading.

Urban development and new construction are nearly non-existent in the watershed. However, future growth is likely given its close proximity to a major city, Lake Charles. There are many positive attributes that could attract growth. Therefore, it is important for the government for local parishes and local communities in the watershed to work together and plan strategies for “smart growth” and “low impact development”. Actions should be taken to develop proper zoning and ordinances, which protect and conserve natural resources. Controlling NPS pollution and improving water quality in the watershed will require a concerted effort involving representatives and officials from each of the four different parishes, which make up the land area within the watershed.

Although, some of the BMPs and the recommended course of actions were described within this plan, a consolidated list of BMPs recommended for each of these land uses can be viewed in the State of Louisiana Water Quality Management Plan, Volume 6, *Louisiana’s Nonpoint Source Management,* 2000. The spreadsheet below in the Appendix lists a total amount of the conservation practices installed for Marsh Bayou. These BMPs were implemented through the NRCS programs for the past 5 years in the Marsh Bayou watershed.

Appendix

Plan County	Land Use	Practice Code	Practice Name	Resource Concern	Total Amt Applied w/in past 5 yrs.
BEAUREGARD	Pasture	314	Brush Management	Inadequate Quantities and Quality of Feed and Forage	540.2 total ac
BEAUREGARD	Forest	327	Conservation Cover	T&E Plant Species: Declining Species, Species of Concern	31 total ac
BEAUREGARD	Crop	329	Residue and Tillage Management, No-Till/Strip Till/Direct Seed	Sheet and Rill	30 total ac
BEAUREGARD	Crop	329A	Residue Management, No-Till/Strip Till	Sheet and Rill	784.4 total ac
ALLEN	Forest	338	Prescribed Burning	T&E Plant Species: Declining Species, Species of Concern	222.8 total ac
ALLEN	Wildlife	338	Prescribed Burning	Inadequate Food	235 total ac
BEAUREGARD	Pasture	342	Critical Area Planting	Inadequate Quantities and Quality of Feed and Forage	144.3 total ac

BEAUREGARD	Pasture	378	Pond	Inadequate Quantities and Quality of Feed and Forage	1.00 total ac
BEAUREGARD	Crop	382	Fence	Sheet and Rill	3488.00 total ft
BEAUREGARD	Pasture	382	Fence	Inadequate Quantities and Quality of Feed and Forage	7,400.00 total ft
BEAUREGARD	Crop	393	Filter Strip	Sheet and Rill	30.90 total ac
ALLEN	Forest	394	Firebreak	T&E Plant Species: Declining Species, Species of Concern	36,733.00 total ft
BEAUREGARD	Crop	410	Grade Stabilization Structure	Sheet and Rill	8.00 total
BEAUREGARD	Crop	449	Irrigation Water Management	Sheet and Rill	317.60 total ac
BEAUREGARD	Crop	464	Irrigation Land Leveling	Sheet and Rill	452.9 total ac
BEAUREGARD	Pasture	464	Irrigation Land Leveling	Inadequate Quantities and Quality of Feed and Forage	122.3 total ac
BEAUREGARD	Forest	490	Tree/Shrub Site Preparation	T&E Plant Species: Declining Species, Species of Concern	31.00 total ac
ALLEN	Forest	490	Tree/Shrub Site Preparation	T&E Plant Species: Declining Species, Species of Concern	164.8 total ac

BEAUREGARD	Pasture	511	Forage Harvest Management	Inadequate Quantities and Quality of Feed and Forage	24.30 total ac
BEAUREGARD	Pasture	512	Forage and Biomas Planting	Inadequate Quantities and Quality of Feed and Forage	167.5 total ac
BEAUREGARD	Crop	516	Pipeline	Sheet and Rill	40.00 total ft
BEAUREGARD	Pasture	528	Prescribed Grazing	Inadequate Quantities and Quality of Feed and Forage	857.5 total ac
BEAUREGARD	Crop	528	Prescribed Grazing	Sheet and Rill	100.00 total ac
BEAUREGARD	Crop	528A	Prescribed Grazing	Sheet and Rill	108.00 total ac
BEAUREGARD	Pasture	528A	Prescribed Grazing	Inadequate Quantities and Quality of Feed and Forage	431.6 total ac
BEAUREGARD	Crop	590	Nutrient Management	Sheet and Rill	471.3 total ac
BEAUREGARD	Pasture	590	Nutrient Management	Inadequate Quantities and Quality of Feed and Forage	125 total ac
BEAUREGARD	Crop	595	Integrated Pest Management	Sheet and Rill	471.3 total ac
BEAUREGARD	Pasture	595	Integrated Pest Management	Inadequate Quantities and Quality of Feed and Forage	300 total ac

BEAUREGARD	Forest	612	Tree/Shrub Establishment	T&E Plant Species: Declining Species, Species of Concern	31.00 total ac
ALLEN	Forest	612	Tree/Shrub Establishment	T&E Plant Species: Declining Species, Species of Concern	164.8 total ac
ALLEN	Forest	645	Upland Wildlife Habitat Management	T&E Plant Species: Declining Species, Species of Concern	262.8 total ac
ALLEN	Wildlife	645	Upland Wildlife Habitat Management	Inadequate Food	145.00 total ac
BEAUREGARD	Crop	646	Shallow Water Development and Management	Sheet and Rill	1272.7 total ac
ALLEN	Forest	666	Forest Stand Improvement	T&E Plant Species: Declining Species, Species of Concern	262.8 total ac